CHEMICAL & METALLURGICAL ENGINEERING

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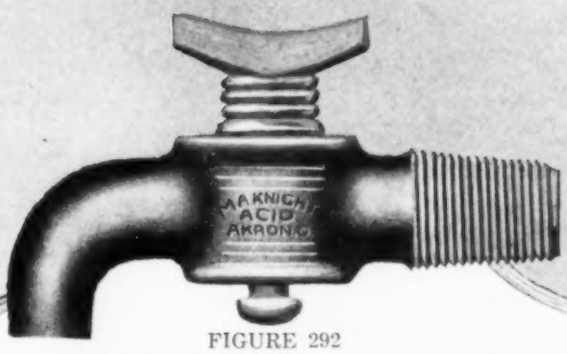

FIGURE 292

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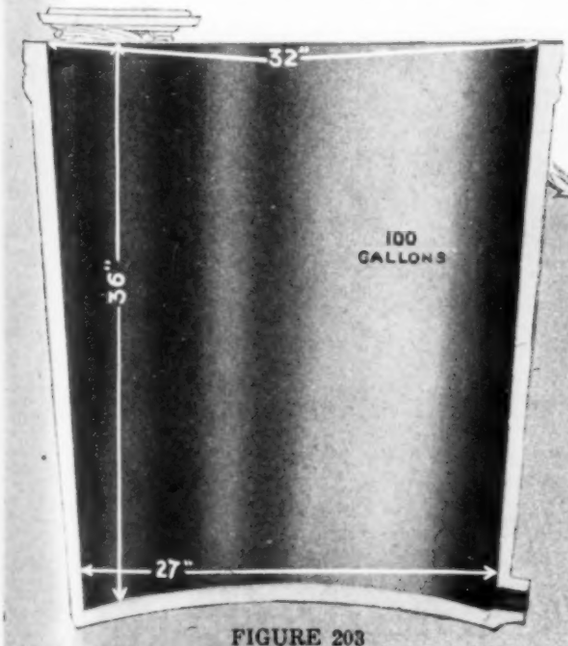

FIGURE 203

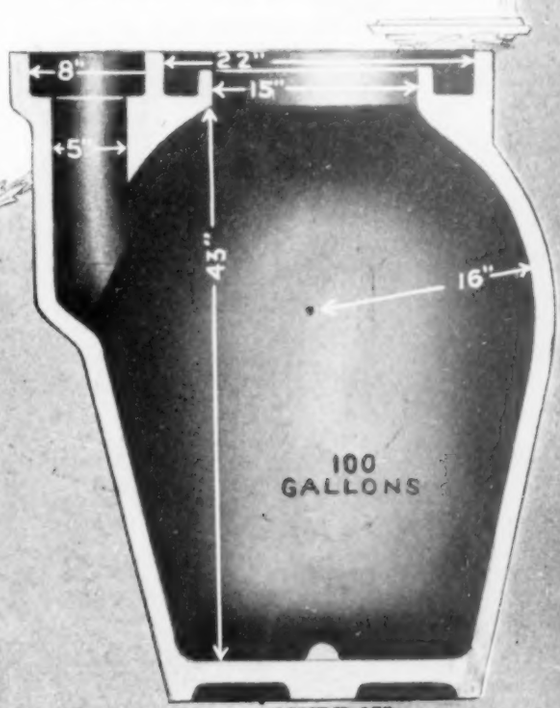

FIGURE 175

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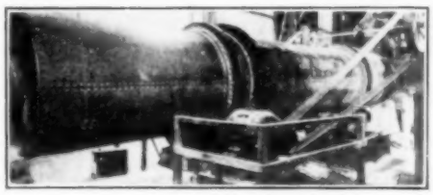

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CHEMICAL & METALLURGICAL ENGINEERING

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Volume 24 — New York, June 1, 1921 — Number 22

Plan to Make New Tariff Duties Immediately Effective

FEW pieces of legislation have aroused as much discussion as has Representative LONGWORTH'S resolution to make the provisions of the permanent tariff bill immediately effective as soon as it is reported to the House by the Committee on Ways and Means. The object of the resolution is to prevent large losses of revenue to the Government while the bill is under discussion, due to the fact that when the proposed higher rates of duty become known importers will promptly bring in large quantities of goods. This loss of revenue has always been recognized and regretted, but hitherto Congress has been unwilling to give immediate effect to legislation prior to its formal consideration and enactment. Evidence is not lacking that this precedent will still be followed, although a determined effort will be made to adopt Mr. LONGWORTH'S plan. It is admitted by all who favor the protective tariff that this would be of incalculable benefit to American manufacturers, but doubt is expressed as to the Senate's accepting the plan, although it is customary in Great Britain, France, Italy, Canada, Australia and other countries.

Experience shows that it requires from five to nine months for tariff legislation to take its regular course through Congress. During this period, as Representative LONGWORTH points out, the loss of revenue resulting from artificially stimulated imports will run into hundreds of millions of dollars "at a time when the Government is in need of revenue as never before, and when the resulting damage to American industries will be incalculable." In similar vein is Secretary HOOVER'S comment in a letter to the Committee on Ways and Means, in which he says:

"It seems to me desirable that the new tariff should be made legally effective upon the introduction of the bill. This is the custom in many countries. It prevents a large amount of speculation. Of even more importance, however, is the fact that during the period of discussion there is always a flood of goods in anticipation of the tariff. This decreases the revenue and renders the position of our commercial community extremely difficult."

This is not the first time that the Committee on Ways and Means has been confronted with this problem. In April, 1917, it sought the advice of the Tariff Commission on the subject and was advised that there could be no valid objection to making the tariff effective on the day on which it is reported to the House provided certain rights of importers are safeguarded. The commission was of the opinion that the proposed taxes should not be collected at once, but that importations could be continued under regulations determined by the Secretary of the Treasury whereby importers could give bond insuring payment of such duties as might finally be enacted. Further, the rights of those who have made, prior to the date fixed, contracts for the sale of taxable imported articles should be protected either by authorizing them to recover from the purchaser an amount equal to the increased tax or by reimbursing them for their losses accruing on contracts on account of the increased duties. The first method was recommended by the Tariff Commission as being in the interest of the Government. With suitable safeguards for importers, it seems right that tariff changes should be made without advance notice to the public, as such notice creates abnormal buying by importers to the detriment of domestic industry and loss of revenue to the Government. If Mr. LONGWORTH'S resolution should be adopted the legislation would put the selective embargo on dyes into almost immediate effect.

For the Improvement Of Society Meetings

SOMEHOW—and frankly we confess that we do not know just how—a change is needed in the conduct of the divisions and sections at the great meetings of the American Chemical Society. Too many papers are presented, and many of them are not worth it. The opportunity for adequate and enlightening discussion in a great many cases is not available. In the Division of Physical and Inorganic Chemistry at the Rochester meeting there were sixty-four papers, and in order to be fair to each speaker his time was limited to ten minutes. But even if it is fair to give each author his fractional portion of the time available such an allotment is not right. What is needed is some kind of a sifting process, so that only important papers are read, and for these there should be plenty of opportunity for discussion. We think, too, that the chairman of each division should avail himself of his high-handed privileges, and cut off discussion that is not germane on the ground that it is out of order. Then if the speaker believes that he has something important to say he can appeal from the decision of the chair.

Censorship is needed, and it may be that for the main portion of these divisional assemblies papers should be presented only on invitation. This would not prevent contributions from unknown authors, because any member would be free to advise the chairman or secretary of the division that he had a paper on a given subject, and accompany it with a digest of its contents and a statement of the time needed for its delivery. Then the officers of the division could determine whether to accept it or not.

One of the leading chemical thinkers of the day said lately that the real meetings of the society take place in hotel lobbies, and suggested that it might be desirable to have rooms set aside and times fixed for dis-

cussions on certain subjects under informal rules, inasmuch as hotel lobbies are inconvenient places for talk. On the other hand, one of the most valuable privileges of these meetings is the opportunity that everyone present has to see and converse with the one authority or person he wants to meet, and the very fact that these miscellaneous assemblies in the lobbies are without specific purpose gives the questing visitor a better chance to find his man than he would have under more definite planning.

At the spring meeting in Rochester last April, generally speaking, the discussions were more important than the papers, and this state of facts is desirable rather than otherwise. Unfortunately this discussion is not recorded and published by the society. But while we would rather praise than find fault with the conduct of the divisions we think most serious minded members will agree that papers are getting too numerous and that many of them are not worth the time they consume at a general meeting.

The American Electrochemical Society prints and distributes in advance the papers that are to be read at its meetings, whereupon usually a mere abstract is given at the session, although the discussion which follows is based on information because the auditors are assumed to have read those that interest them beforehand. To print such a vast number of papers and to send them to 15,000 members of the American Chemical Society would inflict upon it a bill for printing and postage that would soon deplete its treasury, so that methods which are possible for smaller groups could not be carried out here.

The solution of the problem must be found and agreed to by the vice-presidents and secretaries in charge of the various divisions, and we know full well how difficult it is to effect changes in methods of administration after these have almost become conventions through years of practice. We believe, however, that before the year is out some improvement in this respect may be proposed. It is a hard task, and we are not closing our eyes to the difficulties; at the same time we desire to press rather urgently upon the officers of the various divisions the need of reform in the order and selection of papers presented.

Cracking Brass By Corrosive Reagents

ELSEWHERE in this issue is presented an abstract of an important paper by Messrs. MOORE and BECKINSALE and Miss MALLINSON on "Season-Cracking of Brass." While the conclusions as to season-cracking confirm ideas commonly held by American metallurgists, it is especially important as a contribution to the scant data on what might be called "corrosion-cracking," a phenomenon thought by the authors to be identical with "season-cracking," but induced after a very short lapse of time by the action of special reagents.

Such studies cannot very well ignore the more general problem, "What is the mechanism of failure in metals?" Only by knowing how and why can we take steps to prevent unexpected failure. Without knowing how and why one can only accept unlooked-for fractures as the normal risks of life.

A consideration of the mechanism of metallic fracture brings one immediately to the important work at the English National Physical Laboratory of WALTER ROSENHAIN, who has probably done as much as any other man to substantiate the idea that crystalline grains are cemented together by a film of non-crystalline or amorphous metal, thin sheaths whose atomic arrangement is very confused, corresponding to neither of the abutting grains nor to any definite intermediate orientation. Consequently even the purest metal is a complex aggregate, and its behavior will depend largely upon the relative amount and individual properties of the two phases and their mutual arrangement.

Crystal grains may be made to grow to such size as to comprise the entire cross-section of a wire or small test-piece, and their properties are thus capable of determination. Crystals support moderate loads in an elastic manner indefinitely. If the proportional limit is passed, ductile crystals deform by breaking into block-like fragments, which appear to wheel or slide instantly into new positions and then freeze into greater stability. The piece acquires a permanent set, but automatically has become harder and stronger. Increasing the load still further causes ultimate failure along crystal or gliding planes rather than at the boundaries—that is, rupture is transcrystalline rather than intergranular.

In view of the minute amount of amorphous material in a metal, its properties are known mostly by inference and by experiments suggested by the properties of such well-known amorphous materials as glass, pitch, beeswax or celluloid. Though apparently solid, amorphous material is thought of as merely an undercooled liquid possessing high viscosity. It may yield slowly under relatively low, long-continued stresses; its breaking strength depends upon the time the load is imposed. On heating, it loses strength rapidly. Depending upon the relation between temperature and viscosity, some amorphous materials like pitch yield slowly under continued stress even in the winter time. At normal temperatures, however, amorphous metal is harder and stronger than the crystal itself—rupture is normally transcrystalline. Similar hard, strong amorphous material is doubtless generated at the boundaries of crystalline blocks formed during plastic deformation—hence the hardening and strengthening induced by cold-work.

Such in brief is the amorphous theory, which has done yeoman duty in explaining many bizarre facts. Yet it should be noted that some metallurgists are as irreconcilable to the idea of amorphous intergranular cement as are certain Senators to the Versailles Treaty. LE CHATELIER, HEYN and HATFIELD are their leaders. One may or may not like their ideas, but these dissenters at least must be given credit for forcing their opponents to search out and marshal all their supporting facts. A very useful function for dissenters, truly, for we are all too prone to accept without question the plausible words of authority!

Yet a critical supporter of ROSENHAIN'S theory would be inclined to question MOORE, BECKINSALE and MALLINSON'S statement that "it does not appear to be necessary to ascribe peculiar mechanical properties to the intercrystalline substance in order to explain the phenomena of season-cracking." They have shown that mercury and ammonia react with amorphous material, destroying its strength. Hence corrosion-cracking, like season-cracking, is essentially an intergranular rupture. However, spun cups made from cold-worked brass do not crack as readily as the same cup from soft brass, despite its undoubted excess of amorphous material. The authors think that this is due in part to absorption of the reagent by the amorphous material in the crystalline

slips, thus diffusing the selective weakening. This assumes that the bulk of the new amorphous phase formed by cold work is at crystalline slips rather than grain boundaries—an undemonstrated point, to say the least. Yet, if there is no difference in amorphous material existing at crystalline boundaries and slips, then rupture should be both across and between the grains, because mercury absorption, and consequent weakening, should occur in amorphous metal existing on both kinds of surfaces. But corrosion-cracking is always intergranular.

An aggregate of atoms is either amorphous or not amorphous. Degrees of non-crystallinity are not readily distinguishable. Yet why does mercury or ammonia always seek out the structureless material at the grain boundaries, and never cause rupture in that existing within the crystal, unless the former has certain special properties denied by the authors?

Further Comment on Occupational Diseases

REFERRING to our recent comment on Prof. BASKERVILLE'S report to the American Chemical Society for the Committee on Occupational Diseases, we note in the *Journal* of the Society of Chemical Industry of April 30, 1921, some additional observation by Dr. STEPHEN MIALL.

"Broadly speaking," he says, "constant exposure to any chemical compound is likely to be injurious to health, particularly if it is likely to give rise to dust, fumes, or gas, and . . . an abundant supply of fresh air is the best method of protecting the health of the workers . . . All forms of dust and fumes are bad. Constant exposure to coal dust and tar causes what is known as pitch-makers' cancer, tar being the main irritant in this case. The manufacture of marmalade causes injury to the skin by the peeling of oranges and lemons, fine silica dust affects the lungs in a particular way, etc."

Sometimes excellent measures of prevention do not cure, as was the case of prohibition by the Swiss Government in 1879 of the use of yellow phosphorus in making matches. The workers then felt that they could dispense with all precautions where the alleged "harmless" red phosphorus was used, and the poisonings became more frequent than before. It was necessary to alter the law.

Cases of poisoning by carbon monoxide, nitrous fumes and ammonia are increasing in Great Britain, and yet these cases are almost all due to ignorance of the dangerous character of the fumes on the part of the workers. There is no difficult chemical problem in preventing this form of poisoning. A fatal case of benzene poisoning was noted following "improvements" which decreased the ventilation, and an analysis of the air showed two to ten parts of benzene in 10,000 parts of air. No other cases followed after the ventilation was increased.

Turpentine poisoning produces kidney disease and seems to predispose the worker to gout. Persons who are susceptible to the smell of a newly painted room have attributed the illness to white lead or to other causes. It is hardly believable that a volatile lead compound is given off as a gas or emanation from lead paint, and the experience of the past twenty years indicates turpentine as the delinquent.

Autopsies of fatal cases in New South Wales showed in analyses of livers from 0.1 to 0.9 grains of cadmium per pound with merely a trace of lead. Dr. MIALL believed these occurred in the zinc-smelting industry of that region. The symptoms of cadmium poisoning include kidney disease, constipation and loss of appetite. Zinc is a general protoplasmic poisoning and in the higher animals it causes muscular contraction and kidney disease. Copper, tin, nickel and manganese have injurious properties, but cases of poisoning by them are rare.

White lead has been a fruitful producer of disease. About thirty years ago there were many preventable cases of lead poisoning in Great Britain, amounting in the white lead industry itself to about 400 cases a year, in making china and earthenware 200 cases and in printing, glass, shipbuilding and other industries about 400 more, making over 1,000 in all. Restrictions as to improper use, removal of dust, substitution of an insoluble lead silicate for white lead in the glazes of china and earthenware, rules for wearing overalls, etc., have caused a steady decline. Indeed the number of cases has decreased from over 1,000 cases annually to eleven cases in 1898 and twenty-one in 1919. It is said that lead poisoning is not caused by particles of lead swallowed by the worker, but rather by even more minute particles floating in the air inhaled into the lungs and so getting into the system. The headache complained of by painters is more likely to be caused by turpentine than lead. Diagnosis is difficult, and poisoning by cadmium, turpentine, arsenite of copper and other agents is often erroneously classed as due to lead.

Resignation of A.I.M.E. Secretary

MEMBERS of the American Institute of Mining and Metallurgical Engineers will learn with surprise and regret of the resignation of BRADLEY STOUGHTON, who has been secretary of the Institute since 1913. Mr. STOUGHTON is retiring in accordance with his personal conviction, which has been known to some of his more intimate friends and associates, that the office of secretary of the Institute should not be a permanent one and that too long a tenure of office is likely to create relationships that cannot be terminated agreeably. Past events, not only in the A.I.M.E. but also in other national technical and engineering societies, lend abundant support to the sentiment that retention of a secretaryship by one incumbent for more than ten years is likely to lead to undesirable complications. Mr. STOUGHTON'S resignation is to be accepted at the convenience of the board. When he retires it will be with the good will of all members of the Institute who have had occasion to come in contact with him. During his tenure of office the Institute activities have increased in number and complexity. The membership has increased from 3,500 to over 9,000. Local sections have grown in number from four to twenty-six; technical committees have multiplied until they now number eighteen. The growth in volume of transactions is known to all the members and the public activities and traveling that have fallen upon the secretary are matters that even most remote local sections of the Institute have recognized. The period has been a notable one in the development of engineering societies as factors in the national welfare, and Mr. STOUGHTON can derive no small satisfaction from his personal contribution to this development.

Readers' Views and Comments

Measuring the Flow of Gases

To the Editor of Chemical & Metallurgical Engineering

SIR:—My attention has been called to the article in your May 4 issue by Prof. C. R. Hayward on a device for measuring the flow of gases. This device consists of a differential gas flow-meter in connection with a pipe line. The statement is made in the article that by using plugs with different sized openings in the differential manometer it is possible to calibrate the apparatus with air so that the exact flowage of any quantity of any gas may be read from curves based upon this calibration.

Prof. Hayward does not mention the fact that these calibration curves as determined by the use of air are not applicable for the measurement of any other gas unless it has very closely the same molecular weight as air possesses. This is, of course, for the reason that the amount of gas flowing is inversely proportional to the square root of its molecular weight. It will therefore be apparent that apparatus of this sort stardardized against air would be useless, let us say for a benzene-air mixture, unless recalibrated with a mixture of benzene and air, since the molecular weight of benzene is nearly four times that of air. It is also possible to calculate from the amount of air flowing under given conditions, using the curve derived from a test with air, the flowage that would occur with any other gas under given conditions, provided the molecular weight of this gas is known. It seems to the writer that the article was misleading in that it would suggest that the use of the air calibration curves is universally applicable to all gases.

R. G. KNOWLAND,
Cambridge, Mass. Consulting Chemical Engineer.

To the Editor of Chemical & Metallurgical Engineering

SIR:—There have been published at various times in the literature devices and means of measuring the flow of gas which do not give accurate volumes.

In a recent article by C. R. Hayward in Vol. 24, No. 18, of CHEMICAL & METALLURGICAL ENGINEERING with reference to the measurement of gases, we note that no corrections to the volume as read from a predetermined chart are mentioned regarding the density and temperature variations which may be encountered.

If a brief summary of the fundamental equation be considered concerning the flow of gases through small openings, it will be readily observed that from Torricelli's theorem the velocity of a jet of gas is

$$V = \sqrt{\frac{2p}{d}}$$

Where V = velocity.

p = differential or difference in pressure on the two sides of the orifice.

d = density of the gas.

It is obvious that the velocity and consequently the volume of gas passed is inversely proportioned to the square root of the density of the gas.

Since the orifice meter is calibrated with air (sp.gr. = 1.0) and at some definite temperature (T_1 absolute), then to account for other temperatures and specific gravities, the final volume as obtained from the curve must be multiplied by the following factor, which considers change in gravity and flowing temperatures of the gases metered.

$$Factor = \frac{1}{\sqrt{G}} \times \sqrt{\frac{T_1}{T_2}}$$

Where G = sp.gr. of gas (air = 1.0).

T_1 = absolute temperature base or orifice.

T_2 = absolute flowing temperature.

Inasmuch as numerous investigators are constantly using various forms of flow-meters and considering the importance of accurate measurement of gas, this correction may prove very useful.

ROBERT N. DONALDSON.
Bakersfield, Cal. ROSS MCCOLLUM.

Who Is a Chemist?

To the Editor of Chemical & Metallurgical Engineering

SIR:—It must be evident to a thoughtful employer of chemists that the letter of "Chemically Trained Worker," on "Who Is a Chemist?" published in your April 6 issue, must have been written in a mediæval frame of mind. To be sure, the advertisement in the New York *Herald*, which "Chemically Trained Worker" cites, is not a model of clearness, but when the advertiser stated that "no special experience" was necessary, he revealed himself at least as a very practical person.

"Chemically Trained Worker" is one of those who still bows down before the fetish of "experience." There are actors who have been spouting blank verse for twenty years, but who will never play *Hamlet* acceptably. They have "experience." There are chemists who likewise have had twenty years' experience but who are utterly useless in a laboratory.

Give me a young man with *aptitude* and in a few months I will give him all the experience that he will require. Experience without aptitude is worthless. In the term "aptitude" I include imagination, resourcefulness and ingenuity—all of them worth far more than the "experience" that still hypnotizes employers. I would rather take a young man who was graduated with honors from a good technical institution and whose professors assure me that he has the qualities that I demand than one of those hard-shelled "experienced" routineers who will never make any contribution to the literature of his profession.

New York City. WALDEMAR KAEMPFFERT.

Cost of Nitrogen Fixation in Norway

To the Editor of Chemical & Metallurgical Engineering

SIR:—With reference to the article in your March 23 number, page 531, and comment in the April 20 issue, page 681, your attention is called to Molinari's General and Industrial Chemistry, 1912 edition, pp. 304-307, which substantiates Mr. Jensen. There is also an article in the *General Electric Review* for January, February and March, 1917, called "Literature of the Nitrogen Industries," which is very valuable and bears out in reference to the Birkeland-Eyde process the remarks of Mr. Jensen.

J. W. W. Ow.
Springfield, Vt.

American Oil Chemists' Chicago Meeting

Progress Shown Through Reports of Committees—Dr. C. L. Alsberg's Address on Organization of Research in the Federal Service—Barrow-Agee Laboratories Wins Silver Cup on Check-Meal Contest—Engineering Papers, Committee Reports and Officers Elected

THE twelfth annual meeting of the American Oil Chemists' Society, which until this year has been known as the Society of Cotton Products Analysts, was held at the Congress Hotel, Chicago, Ill., on May 16 and 17, the two days just preceding the silver anniversary convention of the Interstate Cotton-seed Crushers' Association meeting at the same location. This organization is perhaps without exception one of the livest aggregations of chemists in the United States, as shown in these annual meetings where discussions and debates are carried on without restraint. Doubtless this is accounted for by the fact that all the members are interested in one subject—namely, the oil industry.

Papers Presented

J. W. Bodman delivered an excellent treatise on "The Manufacture and Grading of Distilled Fatty Acids," outlining the process of double distillation, showing diagrams of apparatus and giving actual operating figures. The diagram of a plant in operation showed a cast-iron fatty acid still about 9 ft. in diameter, 24 ft. in height over all, with copper conduits connecting the dome with the barometric conductor. Copper on an average is more satisfactory than aluminum because it is much easier to obtain coppersmiths for repair than it is aluminum workers at the present time. Receiving eggs are located beneath the barometric condensers and rotary vacuum pumps are connected to the end of the system to draw the vapors through. Normal charge placed in the still is about 15,000 lb. of fatty acid. Superheated steam is supplied from an outside source. One pound of steam distills 2 lb. of fatty acid at the rate of 1,500 to 2,000 lb. of fatty acid double distilled per hour.

By covering the still with 85 per cent magnesia a fuel saving of one-quarter of the total amount burned was effected. Eighty-five per cent double-distilled fatty acid was recovered from foots. No chemical control is used at the present time for determining when the pitch is finished, but the judgment of the operator is relied upon. Something of the importance of the industry of distilling fatty acids may be derived from the fact that in the United States in 1919 the amount of fatty acids distilled was 7,428,000 lb., while in 1920, 89,516,000 lb. was distilled.

Future improvements contemplated involve the elimination of separate heat for superheating the steam and the employment of the latent heat of vaporization as it passes from the still for this purpose.

It has been said that entrained coloring matter cannot be removed from the vapors by any mechanical device, but this has been accomplished by the design of two pear-shaped separators. Vapors are whirled tangentially against the corrugated interiors, giving a scrubbing action. These have been successfully tried out and will do much to increase the yield of white stock in the future.

Recent operating figures show that on a plant of this type the cost per day for actual operation is $88.32, with an addition of $62.50 per day overhead, including interest, insurance, depreciation, etc. The total cost per hundred pounds of double-distilled fatty acid is 65c.

In discussing the grading of fatty acids Mr. Bodman spoke of the various features involved, as to whether the analyses shall be made by reflected or transmitted light, stating that transmitted light as read through a 1-in. cube is probably the best method to be settled upon. He made a special plea for getting away from the indeterminate method of grading acids good, fair and poor, which means nothing.

Organization of Research in the Federal Service

Dr. C. L. Alsberg, chief of the Bureau of Chemistry, gave a short talk on the proposed reorganization of federal research, referring to some of the nonsensical proposals for this reorganization and some of the principles which should govern it.

In discussing what the function of the federal research should be we must consider what is going on at the present time. Congress appropriates money only for things which can be turned into dollars and cents. This is wrong, but it is the actual condition. The primary function of government is to carry on fundamental research which may not be evaluated in the generation in which the work is done. Only the Federal Government can afford to carry on certain types of work which is beyond the pocketbooks of the corporations, because it takes large sums of money for fundamental research and these are available only to the Government. Industries also cannot afford to spend the time required to develop a particular project.

No one can predict the value of definite fundamental researches at the start of the work, yet many pay big, as in the case of the development of the telephone and wireless in the electrical industry. There is no systematic research being carried on today, the work being done hit and miss. Investigation of thermodynamics is much more important than the value of making certain sirups from sweet potatoes, but the money cannot be obtained for the former.

So long as the Federal Government does not recognize the need of fundamental research the Government organization should be patterned after the industrial research laboratory rather than the organization of the university research laboratory.

Canners, for instance, deal with farming and plant industry, the work being divided into agriculture, manufacturing and marketing. What is the use, for instance, of forcing the canner to deal with three separate Government departments instead of one department which understands his whole problem? The commodity should then be handled in one department. There is no logic in such a division as now exists caus-

ing endless duplication and overlapping of the work. Industrial bureaus should have the right to employ any kind of technic in solving the problem for which Congress appropriates the money. We must get away from the idea of a bureau of one science and have one department on each product or industry. We cannot separate production, utilization and standardization, and so must have regrouping according to commodities instead of sciences as long as the Government insists on practical results.

In regard to the regulatory laws which must be administered by scientific men, they are of a corrective rather than a criminal nature, and decisions handed down must be constructive. Such will be the case if the laws are administered by a department familiar with the particular industry in question.

Our Government is not doing its duty in regard to fundamental research, and this is because the public is not asking for it. Consequently we are passing through a difficult period. Industries are hostile because of fear of inventive competition. This will be removed if the Government carries on more fundamental research than that which is immediately useful. The organization would be especially effective for industries composed of numerous small companies and not so necessary as in the case of the electrical industries which are controlled by a small group, for instance.

Rancidity: Its Cause and Prevention

Robert H. Kerr, of the Bureau of Animal Industry, outlined the organization for handling samples at the bureau in analyzing for spoilage due to rancidity and other causes. The other causes involve decomposition of insoluble proteins by bacterial action. Literature on rancidity is incomplete, no systematic study ever having been published.

Fats change due to a shifting of atoms in the glyceride molecules and polymerization; due to reaction with water, and the entrance of oxygen forming an infinite variety of products. There is really little known of the organic compound formed with oxygen.

Rancidity is distinguished from sweetness by common methods—namely, odor, taste and a definite Kreis test.

The bureau has spent considerable time on research as to the development of rancidity and found that it does not occur without the admission of oxygen. If there is no oxygen present a fat never becomes rancid. Four bottles of cottonseed oil placed in a dark room for ten years, three sealed with glass stoppers and one with cork, showed the oil in the three with the g'ass stoppers to be in perfect condition at the end of that time, while oxygen leaking through the cork had made the contents of the fourth bottle become rancid.

Light helps rancidity. Oils placed in blue bottles will become rancid quicker than those in brown, due to the actinic rays. Heat promotes rancidity, as demonstrated in refrigeration sample comparisons. Moisture aids rancidity. So do certain metals, chief among which are copper, zinc, tin and aluminum. Sterilization has no effect on rancidity, an unsterilized fat becoming rancid as quickly as one which has been thoroughly treated. Glycerides of unsaturated acids become rancid quickly. Foreign earths used for b'eaching promote rancidity. All fullers earth has oxidizing power.

No case of rancidity refutes the theory that oxidation is the cause of it. The present practice for the prevention of rancidity of oils in tank cars, etc., is sound and cases of rancidity, where they occur, are due to departure from standard practice. The main thing is to keep tank cars, packages and containers filled and tightly sealed.

Other Papers

Papers read by title only were: "Observations on the Use of Solvent Extraction in the Vegetable Oil Industry," by Glenn H. Pickard, and "The Wording and Impracticability of Certain Parts of the Rules Covering the Oriental Oils."

Committee Reports

The chief work of the two days' meeting was devoted to reports of numerous committees involving vital facts and findings relative to the vegetable oil industry. All discussions were permitted only when a motion was before the house, which had the effect of securing prompt action and warm discussion. President Porter admitted of no straying from the main issue.

The membership committee, reporting 263 members, recommended an elimination of the requirement for membership which involves that a member have at least five years chemical training. The members voted down this recommendation, preferring to keep up the bars and maintain the high standard of the society.

Herbert S. Bailey, editor of the Chemist Section of the *Cotton Oil Press*, the official publication of the society, urged the members to enter a plea for more advertising for the annual issue.

Check-Meal Work

Dr. F. N. Smalley made numerous recommendations for the check-meal work for 1921-22 having to do with the mechanism of the contest for the silver cup awarded for the best analysis of certain samples each year. The suggestion that the announcement of the winners and awarding of certificates shall be made only at the next annual meeting was voted down by the members, since it was considered that publicity was necessary to earnest competition.

Co-operation in Research Committee

Reporting the findings of the co-operation in research committee, P. S. Tilson referred to the outline published by Herbert S. Bailey in Chemical & Metallurgical Engineering, vol. 23, No. 10, Sept. 8, 1920, p. 441, as a brief but apt outline of the situation. Members that are eligible may apply to the National Research Fellowship. Mr. Tilson is anxious to place a list of research problems for the universities to work upon and to raise $25,000 from the membership for a co-operation plan like that carried on by the Mellon Institute and Massachusetts Institute of Technology.

Moisture Committee

W. D. Richardson, of Swift & Co., reporting on the work of the moisture committee, stated that drying tests made showed that during drying there was decomposition of the oils evolving small quantities of water, and that oxidation took place, adding to the weight by absorbed oxygen. The best that can be done is to adopt a standard oven and procedure. Blueprints of a jacketed oven where a glycerine water mixture was used in the jacket and heated by electric coils were submitted. This oven has been tried out for several

years by Swift & Co. and found to be inexpensive and satisfactory. It is further provided with a condenser at the end of the system and has produced very concordant moisture figures. The drying time employed was four hours at 102 deg. C. on the inside of the oven. Volunteers to use it in next year's check-meal contest are desired. It is needless to try the distillation process of drying, because the committee has found it useless.

Color of Cottonseed Oil and Meal Committee

Dr. David Wesson, reporting on the work of the color of cottonseed oil and meal committee, told of twelve new instruments for this determination which are being completed at the Eastman Kodak Co., Rochester, N. Y., and a second apparatus which is being designed by the Bureau of Standards. The latter depends on the amount of light transmitted to a definite wave length through a definite column of oil. The sample has to be placed in a special trough and measurements are governed by the distance between prisms immersed in the oil. The committee will hold a meeting at the Bureau of Standards for investigating this instrument during the summer. In this connection Dr. Priest, of the Bureau of Standards, described the mechanism and mathematics of the instrument involving the kind of light, the properties of the material, and the character of the observer. The advantages of this instrument are universal validity, and standardability.

Bleach Test and Fullers Earth Committee

The bleach test and fullers earth committee has checked the standard method of analysis and agrees to no change. The interstate rules bind the members to the use of English fullers earth, since the domestic is not so good for bleaching, but everyone is after the matter to discover the proper material.

Damaged Seed and Seed Analysis

The damaged seed and seed analysis committee reported that questionnaires were sent to the commercial chemists of the South for standardizing reports, and rules were proposed. The results should be reported as yield of 1,900 lb. of available seeds. The damaged seeds should be reported by count and not by weight. The percentage of damaged seeds should not be taken into consideration when figuring the yield.

Ammonia Committee

The ammonia committee in reporting on questionnaires stated that of the replies sent out eighty-six answers were received, sixty-three of which used the Gunning mercury method, twenty the Gunning copper method and the remainder the Kjeldahl method. All but seven replies used some form of trap bulb in the analysis. Arrangements have been made for the General Chemical Co. to prepare a standard supply of ammonia sulphate and ammonia carbonate for distribution in checking samples.

Oil Constants Committee

L. M. Tolman, reporting for the oil constants committee, stated that an active effort would be made during the coming year to get a large collection of authentic samples for the Buerau of Chemistry to work upon for building up a set of analyses of American oils. The name of this committee was changed from the oil constants committee to the oil characteristics committee.

The report of the soapstock committee is given complete on page 43 of the May issue of the *Cotton Oil Press*.

Sampling Committee

E. R. Barrow, in a lengthy report of the findings of the sampling committee, presented drawings to show various types of designs to be considered for standard use in sampling in tank cars. The American Oil Chemists' Society 1920 sampler, and the Fash sampler, were recommended for special consideration. During the discussion on this report Dr. Wesson insisted that the purchaser should be allowed to empty the tank car and mix the contents before sampling instead of taking the core of the cars as is now done. The solution seemed to be that the shippers should take samples while loading the car and the purchaser while unloading. The report was finally referred to the chemists committee.

Business Meeting

Dr. David Wesson presented a code of ethics for the adoption of the society which each member should sign, involving the following points: (1) Purpose of the code to define rules of professional conduct. (2) Conduct to be in accordance with the highest ideals. (3) To uphold the standing of the profession with the public. (4) To behave as a gentleman and exalt the vocation. (5) To refrain from unreasonably low charges for professional services in order to advertise. (6) To refuse to lend name to questionable enterprises. (7) Differences and disputes between members to be referred to the governing committee. (8) To do nothing contrary to law and public welfare. (9) That it is unprofessional to advertise in any way except by legitimate business cards and its insertion in proper section of advertising mediums. (10) To serve only one client in each case. After some discussion the code was adopted by the society with the exception of No. 9.

The officers elected for the coming year were: President, C. P. Cluff, American Cotton Oil Co., New York City; vice-president, L. M. Tolman, Wilson & Co., Chicago; secretary-treasurer, Thomas B. Caldwell, Law & Co., Wilmington, N. C.

Banquet

On Tuesday evening the members enjoyed an informal banquet at the City Club quarters, 315 Plymouth Court. The principal speaker of the evening was Dr. W. Lee Lewis, head of department of chemistry of Northwestern University and chairman of the Chicago Section of the American Chemical Society. His talk was replete with an unusual number of witty anecdotes, while the serious part was devoted to research at the university with reference to the Hoskins-Wiles plan for the promotion of scientific research as outlined on page 689, vol. 24 (April 20, 1920), of CHEM. & MET.

Other speakers of the evening were Dr. David Wesson, who told some unusually good stories and was followed by L. M. Tolman, who made personal references to all the members at the speakers' table. Dr. F. N. Smalley made the presentation speech for the silver cup on the check-meal contest, which was awarded to the Barrow-Agee Laboratories for the best work carried on over a period of three years. Herbert S. Bailey acted as toastmaster. The meeting closed with a vote of thanks to the chairman of the local entertainment committee, Dr. L. M. Tolman, for taking care of the members during their stay in Chicago.

Drill Steel From Hollow Ingots

A Definite Effort to Produce Hollow Drill Steel With a Decarbonized Interior Surface by Inserting a Mild Steel Tube in the Ingot Mold, Plugging It With Sand, Casting the Steel and Subsequently Rolling to Size

By P. A. E. ARMSTRONG
Vice-President, Ludlum Steel Co.

HOLLOW drill steel is made by various methods: (1) The drilled billet with a sand-filled core, the general method used in this country. (2) The drilled, pierced, or the drilled and pierced billet, not sand-filled, is rolled down over a projectile or ball much the same as in ordinary pipe manufacture. System (2) is employed largely in Sweden. In Sheffield, England, the general scheme is sand-filling. Swedish hollow drill steel is particularly good and has a world-wide reputation for excellency.

It does not follow, however, that steels made by other methods are not efficient, because they are.

Decarbonized Centers in Swedish Bars

In the Swedish material, a peculiar condition is present. The hole is badly decarbonized by the method of manufacture and the extent of this decarbonization varies in bars of different makes. Fig. 1 shows a polished and etched cross-section of very good grade Swedish hollow drill steel that is totally decarbonized $\frac{1}{16}$ in. deep, and the carbon varies from the carbon of the bar down to iron or carbonless ferrite through another $\frac{1}{16}$ in. Owing to difficulties in illumination, the altered structure is not so prominent as under visual examination.

Fig. 2 shows a much lighter decarbonized zone, being only about $\frac{1}{40}$ in. thick, but with certain radial cracks running from the hole into the bar. In this photograph it will be noted that the body of the steel is very dirty. There are a large number of slag inclusions which follow somewhat the original form of crystallization.

Fig. 3 shows another section of Swedish hollow drill steel with about the same amount of decarbonization as Fig. 2, but with larger radial cracks, carrying the local decarbonization in more markedly than in Fig. 2. The zone of graded carbon content is about three times the width of that in Fig. 2.

Fig. 4 is another sample of Swedish hollow drill steel, much about the same as the others, only with a little heavier decarbonization. All of the bars shown in Figs. 1 to 4 inclusive have been rolled either on a projectile or without one, but they were not rolled with sand in the hole and represent the general run of Swedish hollow steel.

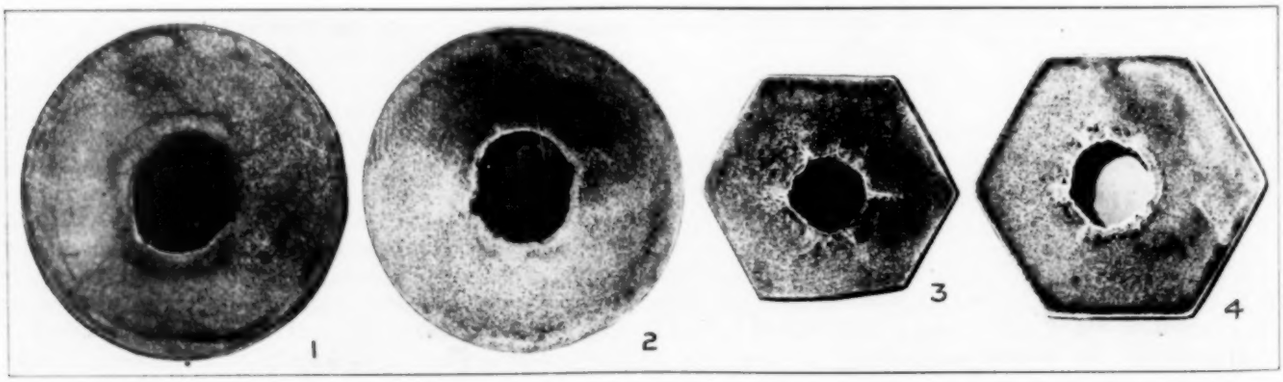
Fig. 5 is a piece of 0.85 carbon, 1 per cent chromium steel rolled from an ingot cast around a mild steel tube. The mild steel lining has a thickness of about $\frac{1}{16}$ in. and there are no cracks from the tube into the metal. There is a slight, but very slight, grading in carbon content between this tube and the metal. The reason for this is that chromium present in steel as an alloy prevents to a very large degree the carburizing of adjacent iron by saturation. I do not say that it is not possible to carburize mild steel by saturation because of the chrome alloy, but merely say it is more difficult than when the chromium is not present.

Fig. 6 shows a piece of 0.85 plain carbon steel having the mild steel tube core, cast and rolled in exactly the same way as that in Fig. 5, yet there is very little of the carbonless iron remaining. A very complete saturation has taken place, which shows very distinctly the difference brought about by the chromium.

Influence of Decarbonized Layers on Hardening

A question that seems worthy of deep consideration is this: Is this decarbonized core an advantage or a disadvantage? If it is an advantage, why not duplicate this by controlled practice and not haphazard means of manufacture? If it is a disadvantage, then why is it that steel of this character has such a good reputation for being a good grade hollow drill steel? There is nothing in the steel that can be discerned microscopically or by analysis that proves it to be superior

A contribution to the Symposium on Drill Steel, New York meeting, February, 1921, American Institute of Mining and Metallurgical Engineers.



FIGS. 1 TO 4. ETCHED CROSS-SECTIONS OF SWEDISH HOLLOW STEEL SHOWING MACROSTRUCTURES

Fig. 1. First-class hollow steel rolled over a mandrel. Decarbonized zone 1/10 in. thick.

Fig. 2. Less clean hollow steel rolled over mandrel. Decarbonized zone 1/40 in. thick.

Fig. 3. Badly cracked steel with thick region of graded carbon content.

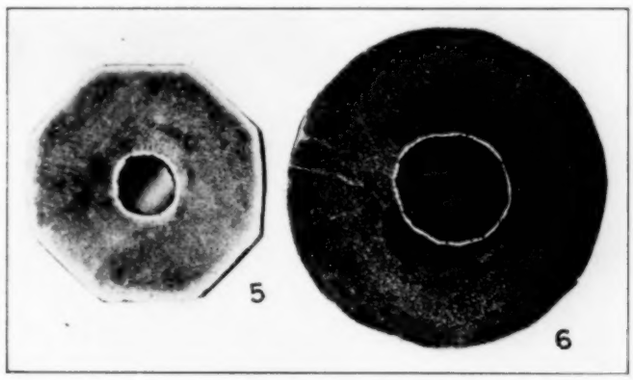
Fig. 4. Heavily decarbonized rod of hollow drill steel.

to hollow drill steel of good manufacture made by methods that prevent decarbonization of the hole. Therefore it is fair to assume that the decarbonized wall of the hole is an advantage. On investigating this subject we found that hardened bars with this decarbonized hole do not become so intensely hard on the inside, neither are they so prone to cracking. Bars with radial cracks are of course bad, no matter what the system of manufacture.

Little Exterior Decarburization

Attention is drawn to the fact that the decarbonized hole shown in the photographs, particularly in Fig. 1, has much greater decarbonized rim in the hole than at the exterior of the bar. This probably may cause some wonder. I believe it is due to the fact that on reheating the bars and rolling them through the various mills the oxide is broken off the bar. When the bar is reheated it is subject to a fresh scaling and is not affected by the scale already adhering to the bar which in itself would set up decarbonization. Therefore, the exterior of the bar has to withstand only the decarbonization arising from the furnace gases and later the adhering scale from that heating; whereas the inside of the tube is affected by adhering scale at all times, adding to the decarbonizing effect of the reheating. The scale is partly reduced by the carbon in the bar, and as the scale is thicker the action is more pronounced.

The mild steel or decarbonized iron inside the hole acts as a damping effect when hardening is produced.



FIGS. 5 AND 6. HOLLOW STEEL ROLLED FROM CHROMIUM AND CARBON INGOTS CAST AROUND A MILD STEEL TUBE

This effect can probably be readily appreciated when the fact is remembered that if a piece of, say, 1 per cent carbon steel be rough-turned so that all decarbonization is removed from the outside of the bar and this be heated up to just above the transformation point and quenched in water of, say, 70 deg., the bars will come out hardened in spots in a non-uniform manner. Some places will be hard; others will not. If a further length of the same steel be rough-turned and then ground and polished, this bar, subjected to the same heat-treatment and same speed of cooling, will come out quite file hard all over and not at all spotty. The reason for this is that the rough-turning holds the steam arising from the heated metal in contact with the water, and thus causes certain zones to cool at a slower rate than those places where the steam which is generated was quickly removed.

In the case of the polished bar, there is no roughened exterior to hold steam pockets, and the steam, as generated, quickly rises to the surface of the cooling fluid and the bar is uniformly hardened over its entire surface. If this bar, which is polished, were covered with a thin tube, then the hardening would not be very pronounced underneath the tube. This of course would vary with the thickness of the tube and whether or not the tube was in good contact with the bar. Such a condition can artificially be produced by decarbonizing the surface of this polished bar. If this decarbonization is carried to a fair depth, say ½ in., the bar will not be of maximum hardness underneath the decarbonized area after being quenched in water. The thicker the zone the less will be the hardness, and for the same reasons which prevent one from uniformly hardening a piece of similar carbon steel right through to the center when quenched from just above the transformation point. Another way of saying this is that the speed of cooling is only fast enough for a certain amount of penetration or depth of hardness. To harden right across the cross-section, alloy steels have to be resorted to, which have a greater lag to transformation.

Hollow Steel From Hollow-Cast Ingots

Hollow drill steel made by casting the metal around a tube and mechanically working the hollow ingot down to the required size (filling up the hole with sand and later removing same after rolling) will have an artificially produced equivalent decarbonized core which will be free from any such tendency toward splitting and driving in radial cracks as has been noticed in the photographs. The surface of the inside of the tube will be comparatively smooth, giving a uniform cooling rate to the inside of the bar, again reducing the tendency for a radial crack to start.

One of the reasons why the carbonless walls of the tube of the bars made by this method do not crack in manufacture is because the mild steel tube is not the result of a decarbonized steel highly impregnated by oxygen and oxides and having a number of microscopical holes where the carbon of the carbides last resided. These holes are places of weakness which may or may not weld up, depending on whether the interior of these microscopical cavities is coated by an oxide layer or filled with gas, either from the gas occluded in this steel or that which has penetrated from the furnace atmosphere. Decarbonized steel is, in my opinion, less strong than mild steel which has been originally made in low carbon and worked down to the required size.

The method employed by the Ludlum Steel Co. in the manufacture of hollow drill steel is to insert a high-grade low-carbon mild steel tube, suitably cleaned by sandblast, into an ingot mold and cast the hot metal around the tube. We fill up the tube with some air-excluding material so as to prevent oxidization and scaling of the inside of the tube, generally using a high-grade sand for this purpose. The ingots are then rolled in the usual way down to the finished bar. The bars are cut up to required length and the sand extracted by a special method, which is very speedy and extremely effective.

Segregation in Hollow-Cast Ingots

Segregation is a thing which must happen in all steel solidification and this is responsible for a certain mechanical weakness in the finished bar. If the segregation can be so located as to have very little mechanical

effect, it would be desirable to make the ingots in that manner.

Casting hollow ingots by the tube method is particularly fortunate in this respect. As the segregation which is bound to occur will be concentric with the hole and its maximum occurrence is about midway between the exterior of the ingot and the tube wall, this area is very large in circumference, comparatively speaking, and the segregation is comparatively small because the distance between the tube and the ingot mold is small. This thin layer of segregation will be most noticeable at the top of the ingot. It can have no effect or at most very little effect upon the bar, as the segregates do not, under any circumstance, creep through to either the exterior or the interior wall of the ingot. Segregation is not removed at all in the pierced billets from solid ingots and is only very indifferently removed in the case of the drilled billet. Furthermore, even if segregated impurities are removed by using only the butts of the ingots, and drilling the billets, there is still carbide segregation to contend with. This will run in straight or nearly straight lines, parallel with the wall of the ingot or the line of freezing.

The inside of the hole of a drilled billet must, therefore, necessarily be the weakest place in the billet, resulting in a weak bar. Progressive fracture is easily started from one of these many sources of weakness.

Influence of Crystal Size on Quality of Steel

Crystal size is of great importance. In a general way the smaller the ingot the better the steel. With a small ingot, the crystals are not very large, the crystallites or colonies of crystals not very far-reaching, and the speed of cooling from the liquid to the solid state fairly rapid.

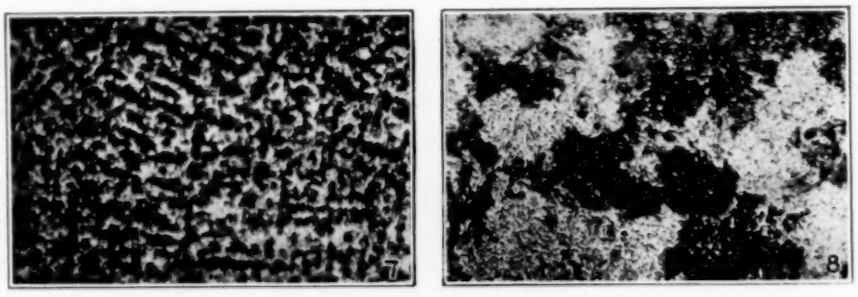
In a 24-in. ingot, for instance, the crystallites are likely to be quite large and likewise the individual crystals forming them. Crystallites are also apt to have a uniform direction for quite substantial distances, depending entirely upon the temperature and the speed of cooling. If the steel is cast hot enough and quickly enough, a fractured ingot will show a complete diagonal structure, the crystallites growing out like columns until they touch one another, leaving room for no equi-axed crystals in the center of the ingot. If the temperature is lowered, the equi-axed zone is larger, and the pine-tree growth, which is the crystallite formation, is less.

A small ingot, although capable of producing a very high-grade steel, is very prone to this columnar structure, even though the temperature of casting be kept down, and there comes a time when the ingots are very small, say 2 in. square or round or whatever shape is desired, when it is almost impossible to cast the steel in such an ingot without producing pine-tree growth complete to the center, and an ingot which is therefore known among workmen as "scorched." An ingot of about 7 in. size can be cast so that it is quite free from excessive pine-tree growth. Crystal formation, however, will be larger in a 7-in. ingot, cast solid, than where the 7-in. ingot is cast with a tube in it, as in the latter case one has all the advantages of a 2-in. square ingot with none of its disadvantages—the sand-loaded core takes up the heat and prevents crystallite growth, besides preventing the formation of large crystals.

The speed of cooling after solidification is slower in the hollow ingot than it is in the solid ingot, therefore the granulation, which takes place after the crystals have formed from the liquid metal, is apt to produce larger grains than in the solid ingot. This is not a detriment. The original crystal size is of much more importance. The size of the grains due to this granulation constantly varies in response to mechanical work and subsequent heat-treatment.

I have found that the size of the grains arising from the granulation of the crystals does not grow larger than the size of the original crystal. Instances arise and should be carefully noted where the crystal boundary is broken and two crystals will appear as one, merely because the solution potential of both crystals are the same and therefore etch uniformly to the external boundary of the two crystals. This is more noticeable when these adjacent crystals have approximately the same orientation.

Two very interesting photographs, Figs. 7 and 8, appear to show conclusively that the casting structure remains in the finished bar. The analysis of this sample is: Carbon, 0.90 per cent; vanadium, 0.25 per cent; manganese, 0.30 per cent. This steel was heated to 1,340 deg. F., a temperature just about its known transformation point, held for some time and then quenched in water. The piece was 1¼ in. round made from a 7-in. square ingot, having a very fine structure in the broken fracture, extremely tough and,



FIGS. 7 AND 8. STRUCTURE OF VANADIUM STEEL ROD. PICRIC ACID ETCHING

Fig. 7. Magnified 30 diameters. Fig. 8. Same region magnified 400 diameters.

generally speaking, a very excellent piece of steel and for the tool for which it was used it gave some extraordinarily good results. Fig. 8 shows the structure as magnified 400 diameters, very fine, peculiar form of sorbite with troostite. Fig. 7 is the same piece magnified but 30 diameters. Here can clearly be seen the cast structure, which has remained in the bar right from the ingot. I believe that this piece of steel, generally speaking, will not have a crystal larger than the governing boundaries of the crystal from original casting. Naturally the crystals in this cross-section, which is at 90 deg. to the direction of rolling, will be smaller in that direction than when originally cast, although their total volume will be approximately the same.

Fig. 9 shows a piece of ⅜-in. square steel which was rolled out of a 10-in. ingot. It is a high-alloy steel and particularly prone to the formation of long crystals, meeting others along the diagonals of the section. During the mechanical work the crystal formation has become somewhat distorted. The structure of the bar, as seen by a fresh fracture, shows this piece of steel to have a very fine grain; the polished surface etched in the ordinary way shows the grain size to be small.

The crystal size is not clearly defined at first, but on prolonged etching the crystal structure of the ingot is clearly shown, while the grain outlines arising from granulation of the crystal have been entirely obliterated. However, the inherent weakness of this steel is laid bare by the prolonged etching with weak acid. This bar is obviously weaker along the original diagonals. All steels will show the original ingot form in the same manner, no matter how far the working may be carried down; some steels have their crystalline structure more readily disclosed by prolonged weak-acid etching than others. It has often been noted that one bar of steel out of heat or a part of the heat will give very much better physical results than another bar from the same heat or out of a different heat, and this is to a very large degree due to the crystalline formation in the ingots. Fig. 9 very clearly shows the reasons for this condition.

Hollow drill steel made from a hollow ingot according to our method is, therefore, a little safer to use when overheating has to be contemplated as a possibility, as the ultimate grain growth will be less than a similar sized ingot cast solid, for the simple reason that the crystals were originally smaller. I do not want to infer that hollow drill steel so made can be overheated and that then the steel will give the same satisfaction as if it were not overheated. I am merely contending that it is slightly less harmful, the reasons being as given.

FIG. 9. ENLARGED MACROSTRUCTURE OF ⅞-IN. ALLOY STEEL BAR ROLLED FROM A 10-IN. INGOT ENLARGED EIGHT TIMES

Surface Seaminess

Surface weakness as shown by seaming and checking on the exterior when working the bars of hollow drill steel, or by cracking in hardening, is in some measure due to the surface stresses of the ingot when cast. We have found out that the temperature of the ingot mold or speed of freezing of the exterior of the ingot is of very great importance in this direction, and much seamy and cracked steel can be laid directly against a too quickly cooled skin. Ingots that are turned or milled all over will not seam very much in working, in fact they are practically free from seams, whereas an ingot rolled without a preliminary machining operation is full of seams and cracks, some long and some short.[1]

It has generally been said that these short seams and cracks in the surface of the bar are the result of elongated depressions in the surface of the ingot and that if an ingot is cast very smooth it should apparently give less surface defects. This is in some measure true, but an ingot cast very hot and having a very smooth skin will crack and seam very badly in the mill. The surface of an ingot poured very cold which is very crinkly, due to the low temperature of the metal, will seam just as badly. The cause of the cracks and seams in one is not the cause of the cracks and seams in the other.

Rough spots on the surface of the very slowly cooled ingot are elongated by mechanical work; roughened places continue to be pressed together, hence seams and cracks in cold-poured metal. In ingots cast very hot the pine trees or crystallites are separated by planes of great weakness at about 90 deg. to the surface of the ingot. These in themselves will cause cracks, the ingot then being known as tender. To draw the happy medium as a basis of our consideration and forgetting extremes, which are really of no moment, when comparing an ingot cast moderately hot so that it is not troubled with excessive dendritic structure and an ingot cast somewhat cooler and having about the same smoothness of surface, there is practically no difference in the amount of seaming and cracking, providing the ingot mold in both instances is cold or nearly so. If the ingot mold is warm, or thinner than usual, there is less surface strain on the resultant ingot and for similar surfaces there are less seams. Ingots cast with a tube in them seem to be freer from these surface stresses and the resultant billets do not have to be chipped or ground nearly as much to produce a bar free of seams and cracks.

Internal Stresses

The smaller the ingot the less will be the tendency for surface seams and cracks which may or may not develop. Those that do not develop may be thought of as locations of inherent weakness. Steel will shrink about $\frac{1}{16}$ to $\frac{1}{4}$ in. to 1 ft. and the steel as poured into the ingot mold will immediately freeze and contract to, say, one-half of the total shrinkage. As the inside of the ingot then begins to cool at a later time, the solid surface is trying to maintain a larger area than is demanded by the lower layers. The exterior of the ingot must then be crushed or the walls sink in, in which case it is under tension in a direction normal to the surface. If the ingot mold wall is concave the ingot when cooling will come practically straight, therefore the surface of the ingot must be under tremendous compression and just beneath the skin of the ingot or the depth of the first frozen layer the steel must be under tension, being held under constraint by the outermost layers, already in high compression. When the ingot is reheated it does not completely remove these strains, and when subjected to mechanical work the ingot will proceed to "let go" in various places—an action which will readily be conceded as being responsible in some measure for seams, cracks and defects of the character under construction. The smaller the ingot the less the actual amount of shrinkage.

In a hollow ingot cast by the tube method the hole

[1]Reference is not made to the seams arising from over-filling or lapping.

is increased in diameter by the freezing. The mild steel tube when heated up to the high temperature imparted by the cast metal is enlarged and continues to be enlarged until it reaches a maximum temperature. It then shrinks while the ingot cools, thereby relieving the exterior surface of the ingot from cracking, or having as much strain as a solid ingot. The mild steel tube will withstand this movement without giving way, whereas an ingot cast hollow but without a tube will not be very good, since the inside of the wall of the tube would be first under tension and then compression, and the metal would withstand these complex forces less well.

The tube method of making hollow ingots for the manufacture of hollow drill steel is a decided departure from the old methods, and the logic of it seems to show that the resultant hollow drill steel should be superior to that made by the older method. Tests made by the Ludlum Steel Co. to date show that such is the case; whether or not our premises are accurate, we believe that hollow drill steel made this way will withstand alternating stresses better than anything that has yet been produced of similar analysis. The reasons why we believe the tube method of hollow drill steel manufacture is superior to the older methods are:

1. Greater freedom from external and internal straining.
2. Because of the inherent small crystal size.
3. Absence of harmful segregation resulting in weakness of the wall of the hole.
4. Less liability for the steel to crack in the inside of the hole during forging or hardening.
5. Toughening effect, arising from the mild steel wall of the hole, limiting the intense hardening on quenching.

Watervliet, N. Y.

Chemical Reaction Affects Casein Glue

Although casein glues are highly water-resistant, they ultimately decompose when exposed to a damp atmosphere for a long time. For many months studies have been under way at the Forest Products Laboratory in an endeavor to discover the cause of this decomposition.

The decomposition study is still far from complete, but the conclusion has been reached that the decomposition of ordinary alkaline casein glues is not due to the action of bacteria or molds. It appears to be due entirely to chemical action of the alkali in the glue. This conclusion is based upon the following observations:

Increasing the amount of alkali in the glue increases the rate of decomposition when the glue is kept wet.

Glues containing no sodium hydroxide, although deficient in some important respects, do not decompose as rapidly as similar glues containing sodium hydroxide.

Cultures of molds and bacteria could not be obtained from decomposed alkaline glues.

Some chemicals which have antiseptic properties are found to improve casein glue, but this improvement is due to their chemical action rather than to their toxic properties.

Glues can be completely decomposed in a short time at temperatures above that at which bacteria can grow.

Further work is being directed toward the production of glues which will resist chemical decomposition and at the same time be impervious to the action of fungi and bacteria as well as moisture.

Rapid Method of Determining Moisture Content of Wood*

The miosture content of pulpwood chips can be found in from seven to ten minutes. A specified weight of wood chips, usually 100 g., is immersed in kerosene in a flask or retort, and the mixture is heated. The water in the chips changes to steam at 212 deg., and goes out through a glass tube in the cork of the flask, is condensed by a water jacket surrounding the tube, and is caught in a measuring glass. The boiling point of kerosene being higher than that of water, all the moisture will be driven off the chips before the oil vaporizes to any great extent. The oil that does go off in the form of vapor is condensed and caught in the same graduate with the water. When the evaporation of moisture is complete, the oil and water are allowed to remain a few minutes until all the water has settled to the bottom of the graduate. The amount of moisture in the wood chips is then found by a direct reading.

This method has been checked for accuracy with the method of weighing samples before and after oven drying, and the variation found to be less than 1 per cent.

Foreign Trade of the Philippine Islands in 1920

The foreign trade of the Philippine Islands in 1920 amounted to $300,562,138, an increase of about $64,000,000 over that of 1919. These figures are the highest in the history of Philippine commerce and were attained in spite of the premium on the American dollar, which ranged from 3 to 12 per cent during the year.

The total imports amounted to $149,438,282.50 and the exports to $151,123,855.50. In 1919 the imports and exports were valued at $118,639,052 and $113,117,826 respectively. The United States contributed 62 per cent, or $92,289,778, of the imports, and absorbed 69 per cent, or $105,216,262.50, of the exports.

The biggest item in the year's export trade was cane sugar, which was valued at $49,619,260, of which $39,349,934.50 worth was consumed by the United States. Next to sugar was Manila hemp, with a total of $35,862,000, of which $20,614,026 went to the United States. Also, the United States absorbed practically all the coconut oil shipped from the Philippines, amounting to $23,268,886.50, and $10,546,303.50 of the cigar exports, valued at $12,721,138.

Significant increases were registered in the import trade. The total value of the automobile imports was $7,460,683, compared to $4,802,324.50 for 1919. Cotton and manufactures totaled $10,117,182.50, as against $7,409,135 for 1919. The imports of iron and steel products amounted to $21,879,602, representing a decrease of $487,985 from that of 1919. Wheat flour importation was $4,721,076, an increase of $256,493 over that of 1919.

Potash in Greensand

In the account of the meeting of the Division of Industrial and Engineering Chemistry at the Rochester meeting of the American Chemical Society R. Norris Shreve was reported as stating in his paper discussing the action of lime on greensand (p 831, CHEM. & MET., May 11, 1921) that analyses of greensand found along the coast of New Jersey showed 3.4 per cent potash. This was an error in transcribing, as the analysis read by Mr. Shreve indicated 7.4 per cent potash in the greensand.

*Forest Products Laboratory *Technical Notes.*

Commercially Pure Iron in the Basic Open-Hearth*

Notes on the Development of a Metallurgical Process for Producing Substantially Pure Ferrite on a Tonnage Basis, Without Containing an Excessive Amount of Gas—Many Modifications in Rolling Mills and Galvanizing Department Were Necessary to Make Finished Sheets

By W. J. Beck
Director of Research, the American Rolling Mill Co., Middletown, Ohio

THE first announcement before a scientific and technical body that the manufacture of commercially pure iron had been successfully accomplished in the open-hearth furnace was in a paper[1] which was read at a meeting of the American Society for Testing Materials in 1911. The following significant paragraphs which remain equally true today are worthy of repetition:

> The industrial history of the country has been characterized during the last ten years by so many important changes and developments that, taken as a whole, they may well be considered as marking a new industrial epoch. These changes may be defined in part as social and political, and in part as purely technical evolution. Thus we find extraordinary change and activity following in the wake of the great movements for conservation of natural resources and government control of the quality of foods, drugs, and other staples which enter into interstate commerce. The day when a complacent public would buy any material offered for sale, with little or no regard for specification and with implicit faith in every word printed on a label, has probably passed, never to return. Quantity rather than quality has heretofore marked the industrial supremacy of the United States, but the signs of the times point to the fact that hereafter the maximum quantity consistent with a standard of quality will be the slogan of the progressive producer.
>
> Europe has long been looked upon as the home of research and conservation, and it is only comparatively recently that America has been brought to a thorough realization of the necessity of re-ordering her ways if she is to take her place in the upbuilding of the industrial future of mankind. It is satisfactory to note that the wave of conservation is sweeping along all the lines of industry, and the ruthless waste formerly so common in manufacturing methods is rapidly disappearing. Almost all new countries, especially if bountifully supplied with natural resources, have had this experience. It is the natural result of rapid growth which leads to a disinclination to consider apparently minor details until forced to do so by stern necessity. The movement for the conservation of our forest products, which is comparatively new in this country, is old and well known in Germany, and it is now very generally conceded that this country has taken up the study of the conservation problem none too soon. It is but natural in this great wave of economy the conservation of iron should have become such an all-absorbing subject. There can be no question but that this important commodity is directly and indirectly the greatest force for civilization that exists.

It cannot be questioned that there has always existed a demand for the purest obtainable irons. This demand has held steadfastly in the face of rapidly developing steel-producing processes. The steady importation of Norway and Swedish irons throughout our entire metallurgical history up to the outbreak of the war in 1914 is sufficiently indicative of this fact. These foreign irons, however, that had to be laboriously worked down by a charcoal or puddling process, were not suited to the large-scale tonnage operations which are made imperative by American conditions of labor and industry. It is natural, therefore, that our metallurgists should have been led to the consideration of adapting the open-hearth steel furnace to the manufacture of iron of at least an equal degree of purity as those types which were imported from overseas.

Before progress along this line could be made, however, grave manufacturing risks had to be faced without much foreknowledge as to whether a successful, workable and salable product could be finally achieved. Every open-hearth man knows what is implied in raising the temperature of a bath two hundred degrees above the normal practice and maintaining this temperature until the carbon and manganese are run down to practical traces.

Development of the Process

The undertaking of pioneer work in this direction was certainly not altogether promising. Ledebur, the great German authority, had clearly stated in his compendious work on iron metallurgy that any such operation with the open-hearth furnace would be in vain if not freighted with disaster. In 1903, however, a very distinguished American metallurgist, H. H. Campbell,[2] made an attempt at an open-hearth pure iron, and finished with carbon 0.025, manganese 0.040. Campbell did not follow up this step, however, and summed up his opinions in the following brief comment: "These heats were made in a basic open-hearth furnace and their regularity both in chemical and physical character shows that we are dealing with a normal and definite metal and not with an accidental product. They were purposely made with the lowest possible content of manganese and it seems positively certain that the metal must be saturated with oxygen." It is evident from the foregoing that so eminent an open-hearth man as Campbell thought that in carrying manganese down to 0.04 the procedure had gone as far as possible and that only an overburned metal was the result.

This then was the history of the effort to produce very low carbon-manganese metal in the open-hearth furnace when the American Rolling Mill Co. first turned its earnest attention to the problem. The very first experimental heats were made in a 35-ton furnace, and they were nursed and watched with the most anxious care day and night. Continuous progress in the art was made until finally it was proved possible to reduce the five ordinary impurities of iron (carbon, manganese, sulphur, phosphorus and silicon) to the point at which in the aggregate they did not exceed fourteen-hundredths of one per cent. At the same time special methods had to be studied to attain the maxi-

*Paper read before the American Iron and Steel Institute, at New York, May 27, 1921.

[1] "The Manufacture of Pure Irons in Open-Hearth Furnaces," A. S. Cushman, *Proc.*, American Society for Testing Materials, vol. 11, 1911.

[2] The Manufacture and Properties of Iron and Steel (1904), p. 482.

mum degree of degasification and the proper deoxidation.

The idea of a commercially pure iron was perhaps but a natural development or evolution of the effort to supply quality sheet metal products. It was believed at the inception of this work that increased purity would lead to increased rust-resistance.

Ingot iron made in an open-hearth furnace differs from the older irons in having a typical crystalline structure, a more definite critical temperature range, and more particularly in being essentially free from slag.

In the first heat an attempt was made to produce a metal containing not over 0.05 per cent manganese. It was done at the risk of losing the heat and the ladle, but it was felt that such a drastic step was necessary in order to determine if it were possible to make such a product in an open-hearth furnace. Care was used in the selection of the raw materials for this heat so that the melt would be as low as possible in carbon and manganese. The heat was charged in a 35-ton furnace and the bath of metal melted low in carbon, as it was believed that the lower the carbon could be driven the lower would be the manganese. Regular open-hearth practice was followed with the exception that an additional quantity of iron ore was added to assist in the removal of the carbon and manganese. In addition to this an excess amount of lime was charged for the purpose of eliminating as much sulphur and phosphorus as possible.

Fig. 1. Casting pit at the open-hearth plant, central works, the American Rolling Mill Co., showing bottom-pour practice.

These early experiments in the open-hearth furnace were made with producer gas as fuel. This fuel was high in sulphur which contaminated the metal and presented a serious obstacle. It was later found that by the use of natural gas this difficulty was largely overcome and it was possible to produce a metal which contained a lower percentage of sulphur.

In order to eliminate as far as possible the impurities in these heats it was found necessary to hold the metal in the furnace longer than is required in ordinary steel practice. In some cases these experimental heats were held in the furnace as much as 50 per cent longer than the ordinary steel heat, with danger to the operators and to the furnace.

On tapping the first iron heat into the ladle it was "wild." The normal amount of aluminum customary in making steel heats had been used, but in later developments it was found necessary to increase materially the amount of aluminum to insure proper deoxidation and degasification.

In the early development of this iron it was made on a small plant basis, using bottom-pour ingots approximately 8 x 10-in. cross-section and weighing about 900 lb. In this bottom-pour practice (see Fig. 1) it was necessary to line with fireclay runner brick the runners which conducted the metal to the ingot molds.

In pouring the first heat the metal was so hot that the stopper rod burned off and there was much difficulty in pouring the metal. The molds were smeared and much of the metal was lost by pouring into the mold pits. Considerable cutting of the runner and ladle lining also occurred.

The ingots were stripped in the usual manner and sent to the reheating furnace for rolling into sheet bars. Here they were rolled into heavy gage bars without difficulty, and later rolled into 16-gage sheets and sheared to size for galvanizing.

As the next step in the operation the sheets were sent to the galvanizing shop for coating. Here considerable difficulty was found in pickling the sheets on account of the slow solubility of the metal, and also on account of the presence of foreign matter such as fireclay from the runner brick and ladle linings. In galvanizing the sheets further difficulty was encountered in the development of blisters and rough surfaces, which were afterward found to be due to imperfect degasification of the metal.

The analysis of this first heat of ingot iron was: Si trace, S 0.028, P 0.003, C 0.03, Mn 0.04. At that time it was customary to analyze only for these five elements—silicon, sulphur, phosphorus, carbon and manganese—the aggregate of these subtracted from one hundred, which was the basis then used, indicating the iron content by difference.

Several years were required to develop the material, even to the point of making this first heat, and for this reason the final and successful result was the occasion for much congratulation among the workers. A new metal with many unusual properties had been given to the world.

Degasification and High Temperatures

In the manufacture of such pure metal the process of degasification was not understood. It naturally followed that a large number of sheets were produced which contained imprisoned gases. When such sheets were galvanized the expansion of the imprisoned gases caused the formation of blisters up to 12 in. in diameter, giving a product which could not be sold even as wasters, and of doubtful value as scrap. This trouble resulted in a further search for a method to eliminate the gases which were responsible for the blisters. Green saplings were used by plunging them down into the bath of metal in the open-hearth furnace after the heat was melted, in an effort to agitate the metal to help remove the impurities. This slightly reduced the time of finishing the heat, but nothing could be found to substitute for the extremely high temperatures necessary to reach the desired analysis of the metal.

These destructive temperatures shortened the life of the furnaces and very greatly increased the cost of the metal. In fact, it was impossible to make this metal continuously in the furnace because of the cutting action on the linings due to the high iron oxide in the

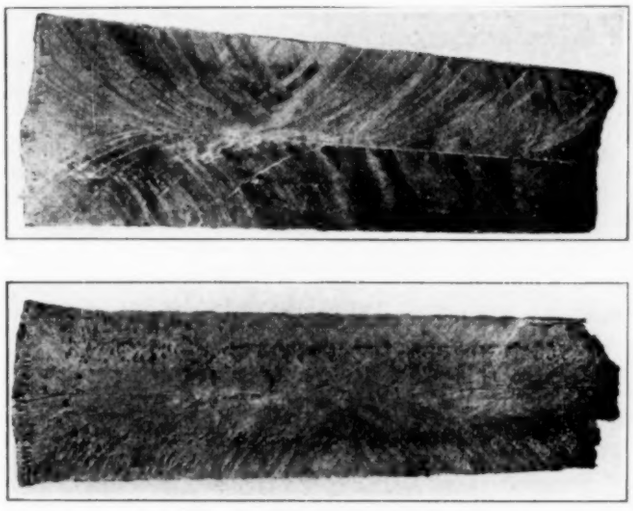


Fig. 2. Photographs of split ingots.

slag. To meet this condition heats of pure iron were alternated with regular steel heats.

The experimental heats of iron produced many unusual and unlooked-for results. One of these heats contained so much gas that nothing but piped ingots were made. In fact, some ingots were piped from end to end with only a thin wall. These had the shape of the molds and weighed but a few pounds, whereas they should have weighed approximately 900 lb. It was an easy matter for a workman to carry one of these shell-like ingots on his shoulder as a spectacular "stunt" for his fellow workers.

Special efforts to secure iron of extreme purity were continued in the open-hearth department during the years 1906 and 1907. Every effort was made to produce a material of high purity. All practical suggestions (and many that were apparently impracticable) were tried. The principal difficulties, however, remained; that of the control of high temperatures necessary in producing this iron and the proper degasification of the metal.

As the experimental work progressed it was found that there were considerable differences in the practice of producing commercially pure iron as compared to steel practice, which materially added to the cost. In the first place, it required several hours longer to make an iron heat than a steel heat, and the final temperature of the metal was 200 deg. F. higher than a heat of steel. Another marked difference was also found between the percentage yield of metal as compared with the percentage yield when steel was made. The percentage of metal produced was several per cent lower in the iron heats because the high temperatures and longer time employed in the manufacture of iron oxidized more of the iron, which was lost in the slag.

It was also found that this high iron oxide content of the slag was responsible for the cutting action on the stopper rods and bricks and that the scorifying action increased as the percentage of iron oxide in the slag increased. It has been found that the iron oxide in this slag is several times greater than the iron oxide in the steel slag. Some of this iron oxide, however, is derived from the iron ore used in oxidizing the carbon and manganese.

In order to emphasize the importance of the selection of raw materials in the manufacture of commercially pure iron attention is called to the fact that there are certain elements which if they exist in the raw material are not eliminated in the open-hearth furnace. Among these elements which cannot be eliminated are copper, arsenic, antimony, tin, nickel and cobalt.

The Critical Temperature Range

Early ingots were frequently split with a metal saw so that the interior structure and the degree of degasification could be studied. It was found that ingots degasified with a slight excess of either silicon, aluminum or even with the use of a small amount of ferromanganese may be perfectly sound as far as gas pockets determine this factor. Nevertheless, such material will go to pieces when an attempt is made to roll it (see Fig. 2).

This breaking up of material degasified with an excess of degasifying agents led to the discovery of the fact that pure iron had to be worked within a certain range of temperature; otherwise, it was found to be red-short and could not be rolled. It was also found that not only was the rolling of commercially pure iron affected by the presence of impurities from the degasifying agents, but it was materially affected by the presence of sulphur. The higher the sulphur content the more difficult it is to roll this iron at any working temperature. Being almost pure this iron has, like many commercially pure metals, a critical range at which temperature it cannot be worked. This temperature is about 900 deg. C., but for working conditions it is impracticable to roll at temperatures between 800 and 1,000 deg. C. In the commercial manufacture of this pure iron it is necessary to roll the material above the critical range on the blooming mill and below the critical range on the bar mill, which necessitates cooling tables between the two mills, these cooling tables being unnecessary in steel practice.

This delays mill production and adds materially to the cost of iron.

Because of the tendency of the sheets to weld together at the higher temperatures the sheet bars also must be rolled on the sheet mills at much lower temperatures than employed in rolling steel sheet bars.

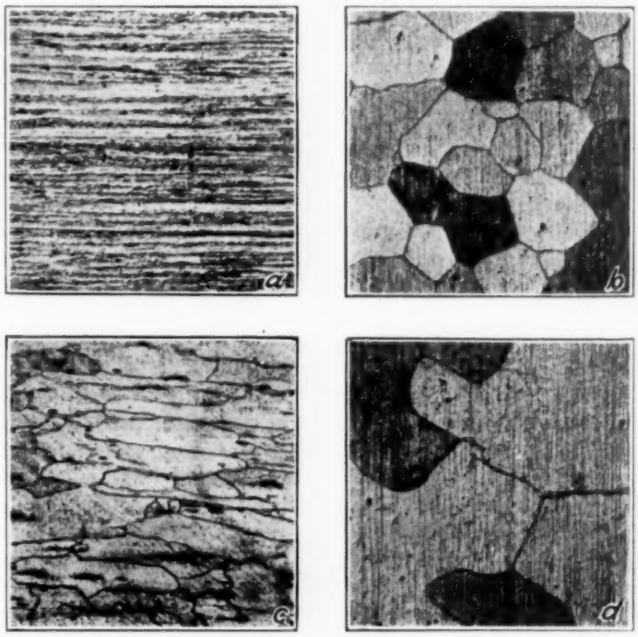


Fig. 3. Microphotographs of Armco ingot iron, × 100. *(a)* Unannealed, *(b)* properly annealed, *(c)* under annealed, *(d)* over annealed.

The use of the microscope plays a very important part in the final treatment of these commercially pure iron sheets, and special care is necessary in the annealing of the sheets in order that they may serve the purpose for which they are intended. Microphotographs of a sheet as rolled on the sheet mill show, first (see Fig. 3*a*) the elongated grains and then after proper annealing (see Fig. 3*b*) the rounded grain structure.

The microphotographs shown in Figs. 3*c* and *d* illustrate very clearly the effect of improper annealing upon the structure of the metal. The elongated grains of a sheet annealed near the bottom of the box (Fig. 3*c*) are due to either insufficient time or to low temperature. The coarse grains, free from strains, of the other microphotograph (Fig. 3*d*) illustrate the grain growth caused by annealing at too high a temperature.

Important Uses of Ingot Iron

Having developed an open-hearth pure iron primarily for its rust-resisting properties, we were gratified to find upon further study that it had many other interesting and valuable qualities, which taken together make a metal for more general use than had been attained by any other ferrous sheet metal product.

The high purity of the metal finally attained is shown by the following average analysis: Si trace, S 0.035, P 0.005, C 0.13, Mn 0.021.

We have found that this pure iron galvanizes in a superior manner to steel. Exhaustive tests have shown that when various grades of steel are galvanized in the same pot and under exactly the same conditions as when galvanizing this pure iron not only will the pure iron take on a heavier coating, but this heavier coating will have less tendency to peel when the metal is fabricated.

We have learned that pure iron goes into solution in molten spelter more slowly than steel; and we have learned that pure iron flux boxes and gears which are immersed in molten spelter will outlast many times similar equipment made from steel. It has been determined by analysis that the iron content of the spelter on steel will average much higher than the iron content of the spelter on pure iron.

Believing that a ferrous metal of such high purity meant rust-resisting properties, we began the study of its behavior under general service conditions. For twelve years the metal has been tested under a great many laboratory and service conditions and the results which have been obtained indicate that it is suitable for many exacting needs where ordinary steel has not proved satisfactory.

The purity of this product and the careful methods used in its manufacture make it more homogeneous than steel, and it therefore flows uniformly when heated to a melting temperature. This characteristic led to its use for many purposes where the cost or efficiency of welded articles depended upon quality of the weld or ease of welding operations. The welding quality of commercially pure iron created a demand for this material in the form of welding wire and rods to such an extent that conversion arrangements were made for the manufacture of large quantities of commercially pure iron welding rods and wire. This material has already largely displaced the welding materials of foreign manufacture previously used in this country. Welding wire made from this metal is used for electric arc welding and gas welding. This iron when drawn into wire has a very low electrical resistance for a ferrous metal. Its conductivity is approximately 50 per cent greater than soft steel, or about 18 per cent of the conductivity of copper.

Another important use of this commercially pure iron lies in its excellent vitreous enameling properties. In the degasification of the metal in the open-hearth process the detrimental gases are practically eliminated. Enameled products made from this iron have a superior finish and are free from blisters, pinholes and other enameling defects.

The average analysis compiled from records covering a period of twelve months gives this iron a purity of 99.865 per cent. This takes into consideration the nine impurities—silicon, sulphur, phosphorus, carbon, manganese, copper, oxygen, hydrogen and nitrogen.

In addition to almost 200,000 tons of ingots which we produced in this country during the past year pure iron made in the open-hearth furnace is being produced abroad and used extensively in Norway and Sweden.

Heat-Treatment of Heavy Forgings

At a meeting of the Washington Chapter, American Society for Steel Treating, May 19, the heat-treatment of heavy locomotive and ordnance forgings was discussed by Lawford H. Fry, superintendent of product, Standard Steel Works, and P. E. McKinney, metallurgist, Washington Navy Yard.

General practice in quenching wristpins, axles, piston rods and connecting rods was described by Mr. Fry and results of experiments were given to show the effects of various quenching media on the properties of both large and small sections. The rate at which heat units are extracted per square inch of surface in quenching is the same for axles as for small test-pieces when using any one of the common commercial media. The hardening effect, however, does not depend upon the rate at which heat units are given up, but on the rate of temperature drop. The following average figures represent the number of heat units (B.t.u.) extracted per square inch of surface per minute by different quenching media:

Air	1.0
Heavy oil	2.7
Cutting compound	3.0
Light oil	3.6
Water	7.0

Vigorous circulation of the quenching bath not only cuts down the time of cooling but may result in superior physical properties.

The importance of "pre-natal" influences in successful heat-treatment of steel was especially emphasized by both speakers. The usual inspection reports covering condition of surface and chemical composition were characterized as inadequate in defining the quality of steel for high-grade forgings and a plea for more general and close scrutiny of melting and forging records by those engaged in heat-treatment was made by Mr. McKinney. Some of the factors having a serious bearing on the final heat-treated product are:

Method used in refinement of steel.
Metallurgical control of conditions of slag.
Methods of introducing ferro-alloys, degasifying agents, etc.
Condition of metal previous to tapping from furnace.
Temperature of metal during refining and finishing.
Size of nozzle used in teeming of ingots.
Methods of pouring ingots.
Size of ingot used for given purpose.
Type of ingot used as regards chilling effect, etc.
Rate of speed in pouring ingots.
Temperature of metal entering the ingot.
Shrinkage of the ingot on cooling.
Behavior of the ingot during solidification.

The Hydrolysis of Fats by Reagents Made From Cymene

A Study of Fat Hydrolises Reagents of the Twitchell Type—Advantages of Cymene Compared With Benzene and Naphthalene—No Preliminary Acidification Required to Obtain Rapid Hydrolysis—Better Color of Products

By RALPH H. McKEE and LELAND J. LEWIS

THE industrial importance of the sulphonic acids as fat-splitting reagents has become so generally recognized that a study of certain of these acids seemed to present a field for useful investigation. Reagents using benzene and naphthalene have been in general use for the past two decades, but heretofore cymene, as a constituent of this type of compound, has not been utilized.

This investigation of the cymene-stearosulphonic acid as a fat-splitting reagent of the Twitchell type was taken up, as it had been noticed that cymene sulphonic acid is soluble in hydrocarbons and oils as well as in water, that it is an excellent emulsifying agent and that it is more easily and cheaply made than most other sulphonic acids. It was thought that these properties indicated its applicability as a fat-hydrolyzing reagent or as a constituent, in cymene-stearosulphonic acid, of a new Twitchell type fat-hydrolyzing reagent.[1]

Advantages of Cymene

This investigation using cymene as a constituent of a fat-splitting reagent of the Twitchell type shows that it possesses the following advantages over the reagents at present employed commercially:

That it is more easily made than the reagents using naphthalene and benzene.

That the reagent can be made at least as cheaply as other reagents on the market.

That a uniform product can be obtained under different conditions of sulphonation.

That the fats and oils are split into fatty acids and glycerine more readily.

That the fatty acid resulting from the splitting of the fat or oil is of a lighter color and hence better.

That the crude glycerine can be produced of better quality.

Twitchell Reagent

The type of reagent used commercially was discovered by Dr. Ernst Twitchell of Wyoming, Ohio, who found that aromatic hydrocarbons such as benzene and naphthalene mixed with oleic acid could be sulphonated to form compounds which fulfilled the commercial conditions requisite for fat-splitting reagents.[2] He writes the following equation when benzene and oleic acid are acted upon by sulphuric acid:

$$C_6H_6 + C_{18}H_{34}O_2 + H_2SO_4 \rightarrow C_6H_4(HSO_3)C_{18}H_{35}O_2 + H_2O$$

He gives this compound the name of benzene-stearosulphonic acid. This nomenclature is based on the assumption that the oleic acid part, which is unsaturated at the start, has become a saturated radical when the reaction is completed. However, there is little definite evidence bearing on the character of the linking between oleic acid and the rest of the molecule.

Preparation of Reagent From Cymene[3]

Cymene, methyl isopropyl benzene, is a byproduct from the manufacture of sulphite pulp from spruce wood. The crude product was purified in the laboratory by one steam distillation and two dry distillations, giving a colorless liquid with a boiling point 174-176 deg. C.

Two hundred and eighty grams of oleic acid and 140 g. of cymene were stirred by a motor-driven (550 r.p.m.) glass propeller; 300 g. of sulphuric acid (66 deg. Bé.) was added gradually, care being taken to keep the temperature below 35 deg. C. The sulphonation was carried out in a beaker.

The stirrer was made of a glass rod with the end of the rod bent up making an angle to the main rod of 45 deg. This end was flattened in order that the blade part of the stirrer would have a lifting effect on the liquid. Experiments carried out with this simple type of stirrer showed it to have a marked effect on the ease with which sulphonation was effected. This is in line with observations made by McKee,[4] who demonstrated that the speed of sulphonation is dependent in part upon the character of the stirring.

As the sulphonation was carried on at 30 to 35 deg. C., it was necessary for the reaction to proceed for a fairly long period. After twenty-four hours' stirring, 500 c.c. of distilled water was added and the whole brought to a boil and stirred. This accomplishes two things: It greatly dilutes the excess of sulphuric acid present in the mixture and it breaks up any oxystearic acid esters[5] that are formed when sulphuric acid acts upon the oleic acid.

The decomposition into oxystearic acid of the oxystearic acid esters is practically complete after the product has been boiling for twenty minutes.[6] The upper layer which separated on standing was a viscous, dark brown, oily mass and contained the cymene-stearosulphonic acid and any unchanged oleic acid or cymene. The lower layer consisted of the diluted excess sulphuric acid together with a small amount of cymene sulphonic acid. As this is soluble in dilute sulphuric acid, it was discarded with the sulphuric acid. The resulting product is pure enough for use commercially, but for exact work such as the present research purer products should be used.

The purification of the cymene-stearosulphonic acid can readily be accomplished, as it is insoluble in water

[1] U. S. Patent Application, Serial No. 461,387.

[2] Reagents of the Twitchell type are also in use where both the aromatic and fatty acid constituents have been modified. See U. S. Pat. 1,303,779 to R. E. Devine and the Pfeilring reagent, *Seifenfabr.*, vol. 38, p. 425 (1918).

[3] Method of preparation is similar to that described by Twitchell: U. S. Pat. 601,603, March 29, 1898; and 628,503, July 11, 1899. *J. Am. Chem. Soc.*, vol. 22, p. 22 (1900).

[4] *Science*, vol. 35, p. 388 (1912).

[5] Lewkowitsch, vol. I, p. 225. Edition of 1913.

[6] Twitchell, *loc. cit.*

containing a strong electrolyte of the type of dilute sulphuric or hydrochloric acid and insoluble in petroleum ether or gasolene, while the impurities are extracted by these solvents.

The crude reagent was agitated with 200 c.c. of 2 per cent hydrochloric acid, brought to the boil and then allowed to stand. The lower layer was again removed. This process was repeated three times. The water from the fourth washing was tested with barium chloride solution and found to be free from sulphuric acid.

To remove the organic impurities petroleum ether was agitated with the oily layer. The petroleum ether separated as an upper layer of a brownish color and contained in solution oxystearic acid and unchanged oleic acid as well as cymene. This extraction was repeated three times. The last ether washing was only slightly colored and when a portion of it was evaporated on a watch glass it left but a faint stain.

As presumably all of the foreign bodies not removed by the washing with water are soluble in petroleum ether, it follows that the product obtained was cymene-stearosulphonic acid containing small amounts of water, hydrochloric acid and petroleum ether. Accordingly it was placed in an open dish on a water bath and stirred continuously for twenty-four hours. A test of a portion, by dissolving in water and adding silver nitrate solution, showed the absence of hydrochloric acid, and presumably water and petroleum ether had likewise been driven off.

Testing the Reagent

The product was further tested for purity by determining its sulphur content and its acidity. The sulphur was determined by converting the sulphur into sulphuric acid by burning in an Emerson bomb calorimeter and converting the sulphuric acid so formed into barium sulphate.

Average per cent sulphur found in three determinations, 6.6 per cent. Per cent sulphur calculated for $C_{10}H_{12}(HSO_3)C_{18}H_{35}O_2$ is 6.4 per cent. Considering the character of the material, a closer check was not expected.

If we accept the empirical formulas of the aromatic stearosulphonic acids as given by Twitchell, a compound of the formula $C_{10}H_{12}(HSO_3)C_{18}H_{35}O_2$ would have a molecular weight of 496. Moreover this acid is dibasic. Twitchell also shows that methylorange indicates about half of the acidity, that caused by the sulphonic acid group, and that phenolphthalein neutrality corresponds to the total acidity. A 2 per cent solution therefore should be 0.0806 normal to phenolphthalein. Titrations with standard alkali of a carefully made 2 per cent solution indicated a purity of 99 per cent when phenolphthalein was used as an indicator.

For comparison the standard Twitchell reagents, naphthalene and benzene-stearosulphonic acids, were made and purified in the manner described above and the sulphur and acid values similarly determined. For naphthalene-stearosulphonic acid the per cent of sulphur found was 6.62; calculated for complete purity, 6.54 per cent. Titration gave a normality of 0.0805, while that calculated from the weight taken was 0.0812. Similarly for benzene-stearosulphonic acid 7.4 per cent sulphur was found, as contrasted with 7.3 per cent by calculation. By titration a normality of the 2 per cent solution was 0.0904, as compared to the calculated 0.0911 normality.

Benzene-stearosulphonic acid and cymene-stearosulphonic acid were also made by a slightly modified process where the sulphonation took place at 98 deg. To prepare the cymene-stearosulphonic acid the oleic acid and cymene were sulphonated with 66 deg. Bé. sulphuric acid, using a steam-jacketed enameled kettle. Time, four hours. The product was purified by washing as previously described. The benzene derivative was made and purified in the same way.

Both benzene-stearosulphonic acid and cymene-stearosulphonic acid were dark. However, the cymene-stearosulphonic acid was not carbonized, as it gave a clear yellow solution with dilute sodium hydroxide. The benzene-stearosulphonic acid showed some carbonization. The acid values of benzene-stearosulphonic acid were almost identical with the corresponding reagents made by cold sulphonation. It will later be shown that these products made by hot sulphonation were identical with the corresponding reagents made by sulphonation at 35 deg. C. when tested by being used in the hydrolysis of cottonseed oil.

Cymene sulphonic acid was prepared by adding 24 c.c. of normal sulphuric acid to 3 g. of calcium cymene sulphonate in solution. The filtrate and washings were taken as a reagent to saponify 300 g. of cottonseed oil.

In addition to the six reagents made as described, there was used a seventh reagent, taken from a sample furnished by a soap factory using the Twitchell process.[1]

Determination of the Speeds of Hydrolysis

The hydrolyses were carried on in 1,000-c.c. pyrex beakers. The heat was supplied by electric hot-plates. The agitation was produced by a stirring device similar to that described above. The cottonseed oil used for

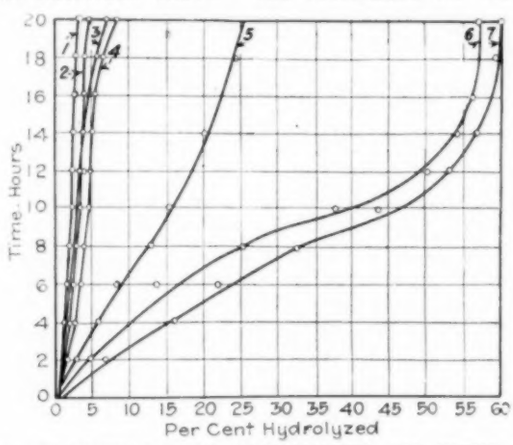


FIG. 1. HYDROLYSIS OF COTTONSEED OIL WITH 1 PER CENT FAT HYDROLYZING REAGENTS WITHOUT H_2SO_4

1—"Kontakt" reagent. 2—Cymene sulphonic acid. 3—Benzene stearosulphonic acid (hot sulphonation). 4—Benzene stearosulphonic acid (cold sulphonation). 5—Naphthalene stearosulphonic acid. 6—Cymene stearosulphonic acid (cold sulphonation). 7—Cymene stearosulphonic acid (hot sulphonation).

the hydrolysis tests was a refined commercial oil of light yellow color having a saponification number of 194 and an acid number of 0.5.

Seven 300-g. samples were taken, and to each sample was added 300 c.c. of distilled water. In each case the weight of the reagent was taken, which was 1 per cent of the weight of the fat. The temperatures were kept almost constant around 98 deg. C. At the end of a 2-hr. run the contents of the beakers were allowed to stand a few minutes in order that a sample

[1] "Kontakt reagent," furnished through the kindness of Dr. ittner of Colgate & Co.

free from emulsion could be taken. The acid number of each oil sample was determined after the method of Sherman,[8] and from this number the per cent of saponification was calculated. Reagents used:

1. "Kontakt reagent," a commercial reagent. 2. Cymene sulphonic acid. (From calcium cymene sulphonate.) 3. Benzene-stearosulphonic acid. (Hot sulphonation.) 4. Benzene-stearosulphonic acid. (Cold sulphonation.) 5. Naphthalene-stearosulphonic acid. (Cold sulphonation.) 6. Cymene-stearosulphonic acid. (Cold sulphonation.) 7. Cymene-stearosulphonic acid. (Hot sulphonation.)

Comparison of Rates of Hydrolysis Without Sulphuric Treatment

The rates of hydrolysis are shown in the form of curves in Fig. 1. It is apparent that cymene-stearosulphonic acid to the strength of 1 per cent of the

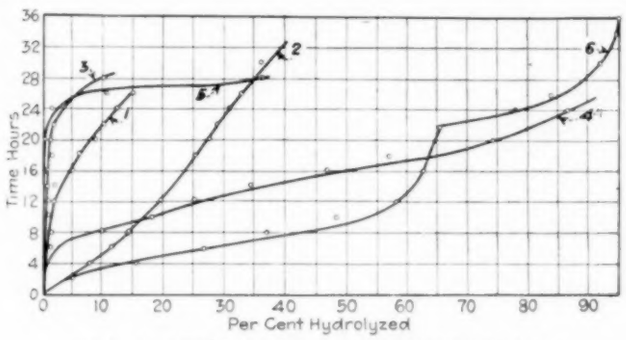


FIG. 2. HYDROLYSIS OF COTTONSEED OIL

Hydrolyzing reagents used: 1—Benzene stearosulphonic acid. 2—Benzene stearosulphonic acid (with H_2SO_4 treatment). 3—Cymene stearosulphonic acid. 4—Cymene stearosulphonic acid. 5—"Kontakt" reagent. 6—Cymene stearosulphonic acid.

weight of cottonseed oil works without the usual sulphuric acid addition, but that the standard commercial hydrolyzing reagents do not work efficiently without sulphuric acid solution. It might be claimed that the method of experiment is scarcely fair to the standard Twitchell type of reagents, as they have been found to work best after the oil or fat has been heated for several hours with dilute sulphuric acid. It is also to be noted that there is but slight difference observed between the acids prepared by cold and hot sulphonation.

Comparison With Sulphuric Treatment

The data given below are for another series of experiments where the reagents are compared under parallel conditions with cottonseed oil again, but in the presence of a small amount of sulphuric acid, except in the sixth experiment.

Benzene-stearosulphonic acid (hot sulphonation) to an amount of ½ per cent of the weight of the oil. One-fifth per cent by weight of sulphuric acid was added. After the twelfth hour the concentration of the benzene-stearosulphonic acid increased to 1 per cent.

Benzene-stearosulphonic acid. The same reagent and in the same amount as above, but the oil heated to boiling for half an hour with 30 c.c. of 2 per cent sulphuric acid before the reagent was added. This preheating is a step often used commercially.

Cymene-stearosulphonic acid. One-half per cent of the reagent was used together with ½ per cent of sulphuric acid. After the twenty-sixth hour the concentration of the cymene-stearosulphonic acid was increased to 1 per cent.

Cymene-stearosulphonic acid. The same reagent as above with the same amounts of the reagent at the start. After six hours' run the concentration of the cymene-stearosulphonic acid was increased to 1 per cent.

"Kontakt reagent." The concentration of the reagent and of the sulphuric acid at the start were the same as those for the other reagents, but after twenty-four hours' run these were increased to 1¾ per cent of the reagent and 1½ per cent of the sulphuric acid.

Cymene-stearosulphonic acid. The hydrolysis of the partly hydrolyzed oil in the previous experiment was continued. The glycerine water was removed at the twentieth hour when the hydrolysis was 65 per cent complete and 1 per cent more of the reagent was added. No sulphuric acid was used.

The results are given in the form of curves in Fig. 2.

Characteristics of the Cymene Reagent

In comparing the rates of hydrolysis of cottonseed oil hydrolyzed by cymene-stearosulphonic acid and certain other reagents, it was noted that the cottonseed oil could be hydrolyzed with 1 per cent of its weight of the cymene-stearosulphonic acid without the addition of sulphuric acid or without resorting to sulphuric acid treatment of the oil. It seemed an important point to determine to what extent the concentration of the cymene-stearosulphonic acid could be reduced and still effect the hydrolysis of the oil. When ¼ per cent of the cymene-stearosulphonic acid and 1 per cent of the sulphuric acid are added to cottonseed oil and an equal weight of water, the acid concentration shown by titration is more than twice the concentration that was used when the oil was readily hydrolyzed. But when this concentration was used practically no hydrolytic splitting of the oil took place. When the concentration of the cymene-stearosulphonic acid was doubled, 0.5 per cent, and the sulphuric acid retained at 1 per cent, the rate of the hydrolysis was very rapid; 25 per cent of the oil was hydrolyzed in two hours, 67 per cent in three hours and 87 per cent in five hours. When a weight of cymene-stearosulphonic acid equivalent to ¼ per cent of the weight of the oil was used and no sulphuric acid added, the rate of hydrolysis was very slow, but was far more rapid than in the above experiment, where ¼ per cent of the reagent was used with 1 per cent of the sulphuric acid.

The great effect of doubling the concentration of the reagent after six hours is shown in the following experiment.

One-half gram cymene-stearosulphonic acid for six hours, ½ g. added at the end of six hours' run. One hundred grams of cottonseed oil used and as usual an equal weight of water: Two hours, 0.5 per cent; six hours, 1.2 (½ per cent reagent added); eight hours, 10.0; twelve hours, 34.5; sixteen hours, 57.4; twenty-two hours, 86.7.

The fatty layer separated much more readily at the eight-hour and later periods than at the close of the two- and six-hour periods.

The above experimental work leads to the following conclusions so far as cottonseed oil is concerned. Later work indicates that they apply as well to other fats as to cottonseed oil:

In the absence of sulphuric acid the new reagent, cymene-stearosulphonic acid, is much more efficient as

[8] Organic Analysis, p. 147. Edition of 1912.

a hydrolyzing reagent than the commercial reagents commonly used.

A certain minimum percentage of reagent is necessary to bring about hydrolysis at a rate that obtains for commercial efficiency—e.g., ½ per cent of the new reagent based on the weight of the fat taken in the presence of sulphuric acid or between ½ and 1 per cent of the new reagent in the absence of sulphuric acid.

In the presence of ½ per cent of sulphuric acid the new reagent is somewhat more effective than two reagents (benzene-stearosulphonic acid and "Kontakt reagent") now used commercially.

Comparative Test on Coconut Oil

In order to gain further information as to the respective merits of the two reagents named, previous experiments (*cf.* Fig. 1) seemingly having indicated that the naphthalene compound was somewhat the better of the commercially used reagents, the time factors in the hydrolysis of coconut oil and later in the hydrolysis of tallow were obtained. The coconut oil[9] used in these experiments had a saponification number of 268 and an acid number of 0.6.

For these comparisons 300 g. of the coconut oil was hydrolyzed with ½ per cent of the reagents and 1 per cent of sulphuric acid. The volume of distilled water was kept as nearly as possible equal to that of the fat. The temperatures were maintained almost constant at 98 deg. C. The data in Fig. 3, curves II and IV, give the comparisons of the speeds of hydrolysis for cymene-stearosulphonic acid and commercial naphthalene-stearosulphonic acid.[10]

From the data given above it is obvious that the coconut oil is much more readily hydrolyzed than the

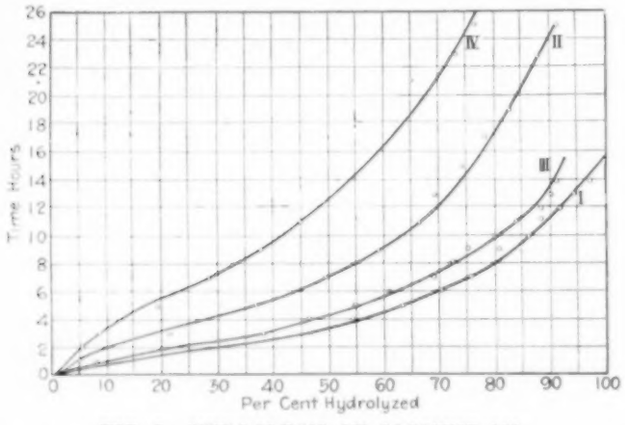


FIG. 3. HYDROLYSIS OF COCONUT OIL.

Hydrolyzing reagents used: I—Cymene stearosulphonic acid 1 per cent, H_2SO_4 1 per cent. II—Cymene stearosulphonic acid ½ per cent, H_2SO_4 ½ per cent. III—Naphthalene stearosulphonic acid 1 per cent, H_2SO_4 1 per cent. IV—Naphthalene stearosulphonic acid ½ per cent, H_2SO_4 ½ per cent.

cottonseed oil. One-half per cent of reagent was effective in bringing about hydrolysis without a previous sulphuric acid treatment, while in the cottonseed oil ½ per cent of the reagents seemed to be too small a quantity to effect a ready hydrolysis. The speeds of hydrolysis were greatly increased when the concentrations of each reagent were doubled and the concentration of the sulphuric acid remained constant.

In comparing the hydrolysis of the reagents, it will be noted that the hydrolysis of the oil was more readily effected with the cymene reagent than with the commercial reagent made from naphthalene and that the difference in this respect was in the neighborhood of 8 to 10 per cent. The fatty acids and the glycerine water obtained where the cymene-stearosulphonic acid was used were of lighter color than these same products obtained by the commercial reagent.

Comparison of the speeds of hydrolysis of coconut oil with 1 per cent cymene-stearosulphonic acid and commercial naphthalene-stearosulphonic acid: 300 g. coconut oil, 300 g. water, 3 g. cymene-stearosulphonic acid

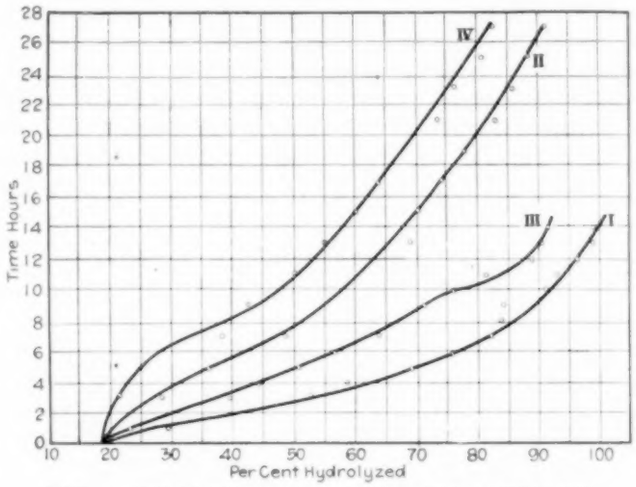


FIG. 4. HYDROLYSIS OF A SOAP GRADE TALLOW

I—Cymene stearosulphonic acid 1 per cent, H_2SO_4 1 per cent. II—Cymene stearosulphonic acid ½ per cent, H_2SO_4 1 per cent. III—Naphthalene stearosulphonic acid 1 per cent, H_2SO_4 1 per cent. IV—Naphthalene stearosulphonic acid ½ per cent, H_2SO_4 1 per cent.

(1 per cent), 3 g. sulphuric acid (1 per cent); 300 g. coconut oil, 300 g. water, 3 g. commercial naphthalene-stearosulphonic acid (1 per cent), 3 g. sulphuric acid (1 per cent). See Fig. 3, curves I and III. At the tenth hour glycerine water was removed and ½ per cent reagent and 1 per cent sulphuric acid added.

Curves II and IV of Fig. 4 give a comparison of the speeds of hydrolysis of tallow with cymene-stearosulphonic acid and with commercial naphthalene-stearosulphonic acid. The tallow[11] was a commercial soap grade product which contained 18.5 per cent of free fatty acid. At the nineteenth hour the glycerine water was removed and ½ per cent reagent and 1 per cent sulphuric acid added: 300 g. tallow, 300 g. water and 1½ g. commercial naphthalene-stearosulphonic acid (½ per cent), 3 g. sulphuric acid (1 per cent); 300 g. tallow, 300 g. water, 1½ g. cymene-stearosulphonic acid (½ per cent), 3 g. sulphuric acid (1 per cent).

Comparison of the speeds of hydrolysis of soap grade tallow with 1 per cent instead of ½ per cent cymene-stearosulphonic acid and with commercial naphthalene-stearosulphonic acid in the presence of 1 per cent sulphuric acid are given by curves I and III of Fig. 4: 300 g. soap grade tallow, 300 g. water, 3 g. cymene-stearosulphonic acid (1 per cent), 3 g. sulphuric acid (1 per cent); 300 g. soap grade tallow, 300 g. water, 3 g. commercial naphthalene-stearosulphonic acid (1 per cent), 3 g. sulphuric acid.

At the tenth hour glycerine water was removed and ½ per cent reagent and 1 per cent sulphuric acid added.

The reagents at both concentrations were effective in bringing about hydrolysis and the cymene-stearosul-

[9]The coconut oil was obtained from Kirkman & Son through the kindness of Mr. Lyford.

[10]Sample of reagent received through the kindness of Dr. Twitchell as a typical saponification reagent. Analysis showed a purity of 92.9 per cent based on the calculated acid value.

[11]A typical soap grade tallow obtained from Kirkman & Son through the kindness of Mr. Lyford.

phonic acid held about the same margin of advantage over the commercial reagent as was shown in the comparison of the speeds of hydrolysis on the coconut oil.

Unlike the hydrolysis in the case of cottonseed oil, which was very slow at the start and which gained speed until nearly 50 per cent was hydrolyzed, with the tallow the hydrolysis was most rapid at the start and the speed fell off as it approached 70 per cent hydrolysis. This would seem to indicate that the free fatty acid present in the tallow at the start was a factor in accounting for the difference in the two reactions. This factor will be discussed more fully in a later section of the paper.

The Darkening Effect Produced in the Fatty Acids During Hydrolysis

The difficulty of producing light-colored fatty acids with reagents of the Twitchell type is one of the most serious drawbacks to the process. In plant practice the utmost care is exercised in excluding air from the fat undergoing hydrolysis until the saponification is complete and the acid neutralized. The darkening of the fatty acid is supposed to be due in part at least to the oxygen in the air. This, while it is the general belief in the plants, needs confirmation.

The color of the fatty acids from parallel runs made in an open vessel with the same concentration of various reagents discussed in previous pages showed wide differences in color. The lightest-colored fatty acids were obtained with cymene-stearosulphonic acid. The curves in Figs. 5 and 6 are from data obtained in comparing the color changes of the fatty acids from coconut oil and from cottonseed oil. A Lovibond tintometer was used to measure the degree of color. The darkening of the fatty acids when the new cymene reagent was used was only about half as great as when commercial reagents were used to effect hydrolysis.

The table gives the color numbers for fatty acids obtained by the three reagents in question. The cell in which the color of the initial and partly hydrolyzed oil was measured was 1 cm. in thickness.

	Initial Color of Coconut Oil		At 30 Per Cent Hydrolysis		At 95 Per Cent Hydrolysis	
Hydrolyzing Reagent Used	Red Scale	Yellow Scale	Red Scale	Yellow Scale	Red Scale	Yellow Scale
A Cymene-stearosulphonic acid	0.08	0.40	0.20	1.10	0.80	4.50
B Kontakt reagent	0.08	0.40	0.45	2.30	1.60	8.00
C Naphthalene-stearosulphonic acid (Twitchell)	0.08	0.40	0.65	3.40	2.40	9.50

Similar comparative results were obtained in the hydrolysis of a prime summer yellow cottonseed oil.

	Initial Color of Cottonseed Oil		At 30 Per Cent Hydrolysis		At 95 Per Cent Hydrolysis	
Hydrolyzing Reagents Used	Red Scale	Yellow Scale	Red Scale	Yellow Scale	Red Scale	Yellow Scale
A Cymene-stearosulphonic acid	0.20	1.20	0.80	3.60	2.20	12.00
B Kontakt reagent	0.20	1.20	1.40	6.00	3.80	16.60
C Naphthalene-stearosulphonic acid (Twitchell)	0.20	1.20	2.00	6.80	4.60	18.60

Conditions Governing Hydrolysis of Fats and Oils

While no special attempt was made to determine the ultimate cause of fat splitting by such compounds as cymene-stearosulphonic acid, naphthalene-stearosulphonic acid and benzene-stearosulphonic acid, some observations were made which will be discussed in a brief review of the several theories on the action of the sulphonic acids in effecting cleavage of fats.

In his Perkin Medal address[12] Twitchell states that even before the discovery of his first catalyst he had stated what properties such a catalyst should possess. These were, namely, that the catalyst should be able to furnish a high hydrogen ion concentration when added

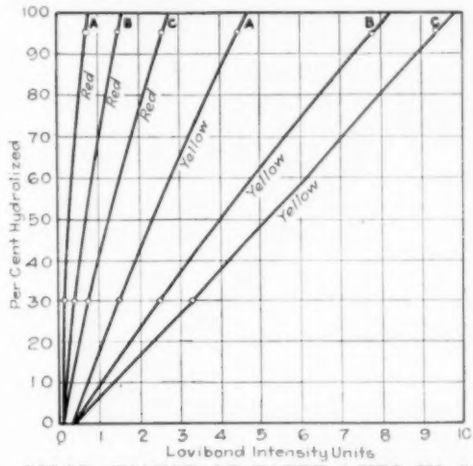


FIG. 5. COLOR CHANGE OF FATTY ACIDS IN COCONUT OIL, MEASURED WITH A LOVIBOND TINTOMETER

Hydrolyzing reagents used: *A*—Cymene stearosulphonic acid. *B*—"Kontakt" reagent. *C*—Naphthalene stearosulphonic acid (commercial).

to a fat and water and in the second place it should be soluble in the fat and soluble in water. Furthermore the reagent must be stable at the temperatures that obtain during the hydrolysis of fat.

The acids benzene-stearosulphonic, naphthalene-stearosulphonic and cymene-stearosulphonic are apparently all dibasic acids dissociating readily in water. One of these acid hydrogens can be approximately determined by titrating against standard alkali using methyl orange as indicator. If phenolphthalein is used as the indicator, both acid hydrogen atoms react and

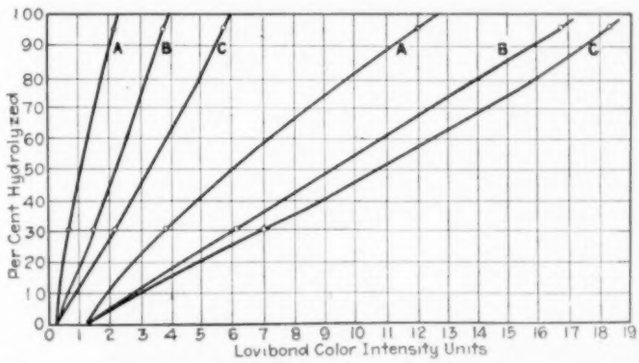


FIG. 6. COLOR CHANGES OF FATTY ACIDS IN COTTONSEED OIL, MEASURED WITH A LOVIBOND TINTOMETER

Hydrolyzing reagents used: *A*—Cymene stearosulphonic acid. *B*—"Kontakt" reagent. *C*—Naphthalene stearosulphonic acid (commercial).

the entire acidity becomes apparent. Tests have shown that they also all meet the other requirements mentioned by Dr. Twitchell, though in somewhat varying degree.

Action of Reagent

The explanation by Twitchell[13] for the cause of the catalytic action of the sulpho fatty aromatic acids is in substance that water becomes a solvent for a

[12] *J. Ind. Eng. Chem.*, vol. 9, p. 194 (1917).
[13] *J. Am. Chem. Soc.*, vol. 22, p. 22 (1900).

glyceride when it contains one of these acids. He points out the fact that esters which are soluble in water are easily hydrolyzed by an acid, while those which are practically insoluble in water are hydrolyzed with great difficulty or are not hydrolyzed at all.

There are, however, a number of cases where water-insoluble glycerides are readily hydrolyzed in a relatively weak acid solution and it would seem that the proof is not conclusive that the rate of decomposition of an ester depends upon the solubility in water. Lewkowitsch[14] has shown that tallow (a water-insoluble glyceride) can be hydrolyzed with 4 per cent of sulphuric acid in nine hours at a temperature of 120 deg. C. Furthermore, the autoclave process for decomposing water-insoluble glycerides does not employ reagents which render the fat or oil soluble in water. Examples of this kind seem to indicate that emulsion formation is the necessary step toward hydrolysis and that the solubility of the reagent in both water and oil phases determines the degree of emulsion formation. On this assumption it seemed important to carry out some experiments to determine if possible the factors that assist in emulsion formation and also to ascertain what changes take place in the water phase during a hydrolysis of a fat.

Distribution of Reagent

Determinations were made to find the distribution of reagent in oil and in water when the proportions of the constituents were about the same as obtains in industrial practice.

The first experiments were carried out with a neutral coconut oil. Two hundred grams of oil and 100 c.c. of a standard solution (10 c.c. equivalent to 53.80 c.c. N/100 NaOH) of cymene-stearosulphonic acid were agitated in a beaker for thirty minutes at 25 deg. C. This emulsion so formed was allowed to stand for one hour. Ten-c.c. portions of the water phase were titrated with N/100 NaOH using phenolphthalein. A difference in the amounts of NaOH required for 10-c.c. portions and of the NaOH required to neutralize 10 c.c. of the original acid solution added gave the amount of the acid which passed from the water phase to the oil phase. Titrations were each made in triplicate using phenolphthalein indicator and the average was taken for calculations.

Ten c.c. of the original acid required 53.80 c.c. N/100 NaOH. Ten c.c. of the water layer after treatment required 51.70 c.c. N/100 NaOH. The acid strength remaining is $51.70 \div 53.80 = 96.1$ per cent. Reagent which passed from the water phase under conditions described above, $100 - 96.1 = 3.9$ per cent at 25 deg. When the experiment was repeated at 60 deg. C., it was found that 8.02 per cent had left the water phase.

Since the presence of fatty acids seemed to increase the speed of hydrolysis in an oil, the above experiments were repeated using 180 g. of coconut oil with 20 g. of oleic acid, the concentration of the reagent remaining the same. It was found that in the presence of oleic acid 5.4 per cent left the water phase at 25 deg. and 11.0 per cent at 60 deg. Accordingly the presence of free fatty acid in the fat or oil serves to make it a better solvent for the hydrolyzing reagent.

A second set of experiments was made with cottonseed oil instead of coconut oil and gave similar results. At 25 deg. 4.2 per cent and at 60 deg. 7.5 per cent of the acid left the water phase. In the presence of oleic acid in the same proportion as with the cottonseed oil it was found that at 25 deg. 5.9 per cent and at 60 deg. 11.0 per cent of the reagent acid left the water phase.

[14] Lewkowitsch, Chemical Technology of the Oils, Fats and Waxes, vol. I, p. 84. Edition of 1913.

Increase in Ionization

In the light of this work it is apparent that one function of the sulphuric acid is to decrease ionization of the reagent and thereby increase the solubility of the reagent in the oil phase. It is apparent in the above set of experiments that the solubility of the reagent in the oil and fatty acid increases as the temperature rises. Some measurements carried out at a temperature of 98 deg. C. showed that the increase in solubility was apparently a straight line function and that at a temperature which obtains when fats and oils are split by the use of hydrolyzing reagents, 10 per cent or more of the reagent is dissolved in a neutral fat and 10 to 20 per cent (depending on the per cent of fatty acid present) is dissolved in fat containing fatty acid or in a fat after hydrolysis has proceeded for a few hours.

The results obtained at 98 deg. C. were variable and not entirely trustworthy because at that temperature the glycerides were broken up into fatty acids and glycerine and the composition of the original substance was changed. At 25 and 60 deg. the hydrolysis which the oil suffered during one-half hour was almost negligible and the values obtained at these temperatures will indicate approximately how the acid is divided between oil and water phases. This is not true at 98 deg. C.

Distribution of the Acid

The whole amount of acid which leaves the water phase is not dissolved in the fat to form a homogeneous solution. Part of the acid dissolves in the fat and part forms emulsions which persist for a considerable length of time when the fat and the acid are allowed to remain quiet.

When water extractions of the unemulsified oil were made and were titrated against the standard sodium hydroxide, the acid found did not correspond to the amount which left the water phase. When a layer of emulsion between the fat and water phases seemed to persist on standing, this difference between acid lost in the water phase and acid dissolved in the oil phase was greater than when almost no emulsion was present. It is the opinion of the writers that the solution of the acid has its greatest concentration at the interface between acid solution and fat and that the greater the degree of dispersion of the oil particles in this area the greater will be the concentration of the acid.

Effect of Acid on Reagent Distribution

Supplementary experiments were carried out in the determination of the distribution of cymene-stearosulphonic acid in the water and oil phases. In these an attempt was made to determine what, if any, effect sulphuric acid had toward driving the reagent from the water phase into the oil phase. Using approximately normal sulphuric acid and the same strength of reagent acid as before, it was found at 25 deg. with cottonseed oil 6.8 per cent of the cymene-stearosulphonic acid left the water phase and with coconut oil 8.7 per cent left the water phase. These values are roughly one and a half to two times the solubility of the hydrolyzing reagent in these oils at 25 deg. when no sulphuric acid was present.

With increase of temperature the percentage of ionization of dilute sulphuric acid changes but little. With increase of temperature the fat hydrolyzing reagent has been shown to be much more soluble in the fat. Accordingly we would expect the presence of sulphuric acid to be particularly effective in increasing the percentage solubility of the hydrolyzing reagent at higher temperatures. Unfortunately, as explained above, it is not practical to make such determinations at the hydrolyzing temperature.

Essential Conditions

It may be necessary, then, to bring about two conditions before an acid will hydrolyze a fat:

The hydrogen ions must be greatly concentrated on the surface of a fat globule.

The fat must be divided until the surface is extremely large in comparison to the mass of the particle to be hydrolyzed.

Nernst[15] states that the hydroxyl ion is 1,400 times more effective than the hydrogen ion in causing saponification. A N/5 solution of sodium hydroxide has practically no action on a neutral fat at room temperature, for a fatty acid can be determined in the presence of a neutral fat by neuralizing the fatty acid in an alcohol water solution with this strength alkali. If the relative activity of the hydrogen and hydroxyl ions in causing saponification is 1 to 1,400, it is obvious that a very extraordinary set of conditions must exist when a fat is hydrolyzed by an acid saponifying reagent of the type that we are studying. In this case a solution of an acid less than N/10 concentration can bring about the rapid hydrolysis of a fat.

Experiments carried out in the laboratory showed that a fat in the form of an emulsion is very much more readily acted upon by an alkali than one which is not in this form. The separation of fat bodies into smaller ones will increase the surface enormously and in this respect it would seem that the speed of hydrolysis[16] is largely determined by the degree of the divisibility of the body that is undergoing hydrolysis.

The presence of a small per cent of free fatty acid seems to aid in the formation of emulsion. It was observed that the addition of oleic acid to a fat undergoing hydrolysis increased its tendency to form an emulsion layer between the fat and water, as was evident from the depth of the layer after the agitation was stopped. This emulsion layer was fairly stable on standing. As shown above, the per cent of acid leaving the water phase was increased when oleic acid was added and when the temperature was raised. In a separate experiment using oleic acid as a solvent it was shown that the sulpho-fatty aromatic acids are taken from the water phase to form true solutions in the fatty layer and in particular in the fat containing fatty acid, also that a considerable part of the reagent goes into the emulsion which is formed. It was further observed that the tendency for the formation of a stable emulsion did not appreciably increase after the fatty acid increased beyond about 10 per cent.

From an examination of the curves on the rate of hydrolysis of cottonseed oil and coconut oil which contained no fatty acids at the start, it will be seen that the speed of hydrolysis was slow at the beginning of the reaction, but increased after fatty acids were formed. The speed after about 40 per cent of the fat was converted into fatty acids fell off gradually. In the hydrolysis of a tallow which contained 18 per cent fatty acids the speed was the most rapid at the beginning of the hydrolysis.

The fact that an emulsification produced by the various types of fatty acids plays a great part in producing the hydrolysis of the glyceride is in harmony with some recent theories advanced on the nature of emulsifying agents. Harkins, Davis and Clark[17] think that the best emulsifying agents have long molecules with a polar active group at one end of the molecule. (Polar groups COOR—COOH, etc.) For the emulsified particle to be stable the molecules which make the transition from the interior of the drop to the dispersion medium or the molecules of the "film" should fit the drop. Langmuir[18] believes that the organic groups strike inward into the fatty globules while the COOH, SO_3H, etc., are outside in the water phase.

These theories on emulsification may explain why reagents like naphthalene-stearosulphonic acid and cymene-stearosulphonic acid are better hydrolyzing agents than benzene-stearosulphonic acid. If we accept as true the common structural formulas for benzene, naphthalene and cymene, the molecule of a compound like benzene-stearosulphonic acid would not possess the length that is found in the two others and it would therefore be less effective as an emulsifying agent.

In one series of experiments the fat hydrolysis was carried out in the presence of iron. It was found that the percentage hydrolysis was not nearly as high as parallel experiments carried out where glass replaced the iron and also that the surface of the iron had been corroded. It is the general belief in the industry that the presence of iron pipes, etc., in the wood hydrolyzing vat is objectionable both from the effect on the speed of hydrolysis and on the color of the resulting fatty acid. The present case is, however, so far as we know the first case where definite experiments to confirm this general belief have been made.

Cost of Reagent

In comparing the merits of cymene-stearosulphonic acid with other hydrolyzing reagents, it is necessary to consider cost of materials and other expense arising from the preparation of these.

The raw materials in question are cymene, benzene, naphthalene, oleic acid and 66 Bé. sulphuric acid. Cymene can be purchased and refined at less cost than benzene or naphthalene. The market quotation for benzene of a suitable grade for hydrolyzing purposes is in the neighborhood of 30c. per gal., or about 4c. per lb., and naphthalene is 8c. to 9c. per lb. Cymene can be procured and purified for about 4c. per lb. Oleic acid of a grade desired for this work costs 7c. to 8c. per lb. Sulphuric acid costs approximately $20 a ton.

On this basis crude cymene-stearosulphonic acid should be prepared in quantity at a cost of about 10c. per lb., the exact cost depending on the care one wishes to take in removing the excess of impurities that are formed or exist in the making of the reagent.

The cost of preparing the benzene or naphthalene compounds would be somewhat higher due to the higher cost of the hydrocarbon and also to the fact that they cannot be sulphonated with the same ease or completeness as can cymene.

Department of Chemical Engineering,
Columbia University.

[15] Theoretische Chemie, Vierte Auflage, p. 532.
[16] Like sulphonation. *Cf.* McKee, *Science*, vol. 35, p. 388 (1912).
[17] *J. Am. Chem. Soc.*, vol. 39, p. 541 (1917).
[18] *J. Am. Chem. Soc.*, vol. 34, p. 1848 (1917).

Season-Cracking of Brass*

Extensive Observation of Season-Cracked Articles Led to Studies of the Action of Corrosive Agents on Stressed Brasses and a Determination of the Minimum Loads Required to Produce Corrosion Cracks—Chemical Action Held to Be Necessary for Season-Cracking

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INFORMATION contained in this very comprehensive and voluminous paper is the result of studies extending over several years, and on a number of different non-ferrous alloys which have failed by season-cracking. Not all of the information is new, by any means; but the paper as a whole is a good presentation of the entire subject.

OBSERVATIONS ON SEASON-CRACKING

Failures in cups spun from a 70:30 brass sheet, 0.07 in. thick (Fig. 1) were first noted. These cups had been covered by a layer of lacquer, which in many cases was unbroken, and the broken metal showed no corrosion whatever. However, they were stored near a mixture

FIG. 1. SPUN VESSEL, 70:30 BRASS, SHOWING SEASON-CRACKS

of materials containing ammonium salts. When examined under the microscope, the metal showed a normal alpha brass structure, and all the cracks examined were intercrystalline. Internal stresses existed in these cups, since strips cut from them spring out of shape.

Empty cartridge cases (Figs. 2 and 3) especially have been affected with this "disease." Cracks usually occur

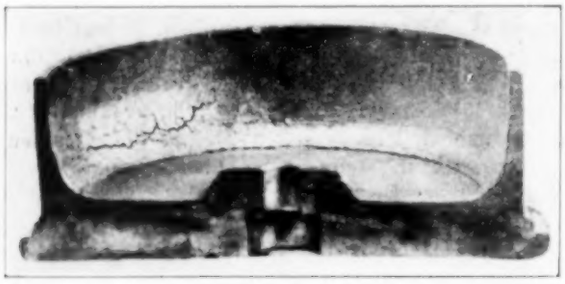

FIG. 2. SEASON-CRACKS IN INTERIOR OF WALL OF CARTRIDGE CASE

in the wall near the flange, and are ordinarily ascribed to incorrect "heading." After the shell has been placed in position, many longitudinal cracks have developed in the neck of the case. Fig. 4 shows the microscopic appearance of a typical crack in such a case made of 70:30 brass. Rings cut from such a cartridge would show that the wall was in tension and the base in compression. Microscopic examination shows no distinguishing feature associated with season-cracking, such as crystal size, marked deformation in a crystal or the contour of crystalline boundaries.

A nickel-plated motor horn (Fig. 5) cracked badly where the plating had been polished off. Stress measurements from rings cut from this piece showed the cracks to start in rings having from 22,000 to 17,000 lb. per sq.in. stress, extending themselves toward regions having less stress.

Cold-drawn rods and tubes of various compositions ranging from pure alpha brass through mixtures of alpha and beta to pure beta brass have suffered high losses after storing. Particularly it was fund that cold weather following a mild spell would be followed by much damage. Such weather conditions condense moisture on stored tubes, slightly corroding them, thus inducing cracking which exists chiefly in corroded regions. Under the microscope selective corrosion is

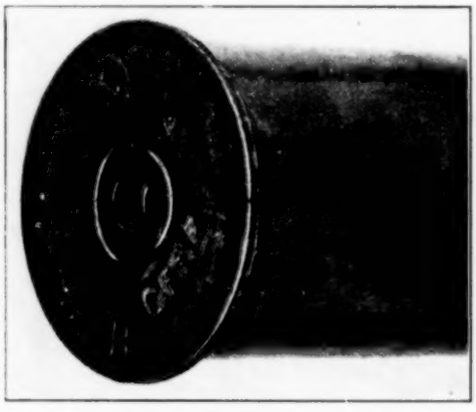

FIG. 3. SEASON-CRACKS IN BASE AND WALL OF CARTRIDGE CASE

very noticable in the beta portion of a compound structure (Fig. 6). It was frequently noted that corrosive discoloration followed down the cracks. On the other hand inclusions were rarely connected with cracks, nor could preference be found for any shape, size or marking in the metallic grains. It was also possible to induce further cracking, in all bars which cracked in storage, by a light pickling followed by an immersion in weak mercurous nitrate. Failures coincided with scorings or surface defects in very rare instances—in fact, this observation applies to all the specimens examined during several years. Using Heyn's method of measuring internal stress—length changes in a sample between scribed lines after portions of the metal had been removed—a season-cracked rod showed stresses equal to 20,000 lb. residing in the outer layers. Uncracked rods which had been stored for a long period,

*Abstract of a paper read before the British Institute of Metals, March 10, 1921.

when studied in the same manner showed no longitudinal stress.

Corroded surfaces of such cracks in bars and tubes studied at Woolwich were green or dull brown in color; when soaked in distilled water a distinct evidence of NH_3 was found by Nessler's solution. No nitrates, however, were found in testing by diphenylamine. It was concluded that smoke from the open fires of green sap wood used in winter to heat the storage shed contained sufficient ammonia to be responsible for this corrosion-cracking. Spun cups known to be highly stressed were held in the fumes from the combustion of green sap wood for a confirmatory test. They were cracked in ten days. Chemical test also showed the atmosphere in the bell jar to contain much ammonia. In fact, ammonia is always found in considerable percentages in rain water from town districts, and therefore should be regarded as a potential source of damage to stressed brasses.

Features Common to Season-Cracking

From all these observations, the authors summarize the following as being common to all season-cracking which has come under their study:

1. The pieces all appeared to be under an initial stress, not induced by outside load and therefore nearly always internal or residual. Such stresses may probably be induced by strain-hardening.

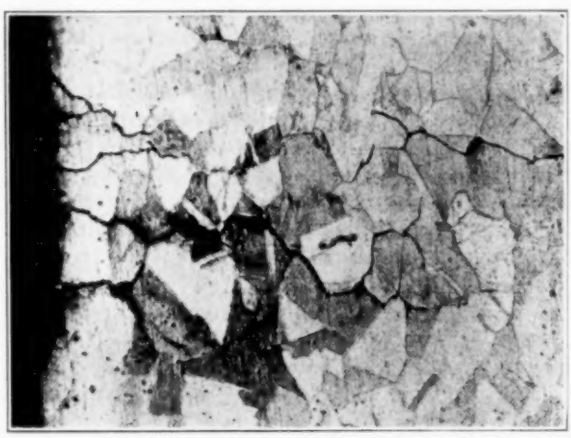

FIG. 4. SEASON-CRACKS IN 70:30 BRASS CORRODED ON THE SURFACE. × 100

2. The pieces were all strain-hardened in a differential manner—that is to say, the hardness was greater in one part than in another part. Whether this is an independent cause of cracking or whether it merely sets up internal strain is not known.

3. Chemical action on the surface seems to be necessary. Very frequently defective articles have been corroded sufficiently for a visible tarnish or even a deeper corrosion. On the other hand, some apparently unbroken lacquered or paraffined coatings did not prevent season-cracking. It was later demonstrated that neither of these coatings is impervious to reagents, especially ammonia, which is often the cause of the trouble. Nickel plate seems to be quite impervious to ordinary corrosion agents.

4. Season-cracking seems to be exclusively an intercrystalline failure.

Effect of Corrosive Substances on Stressed Brass

It had been found by the authors that spun cups made by a smoothly operating manufacturing process could be regarded as having closely similar internal forces. A lot is usually made from a softened sheet from one ingot. It was found that they invariably cracked in from two to three minutes in a 0.1 per cent mercurous nitrate solution, if the cups were first pickled in a dilute solution of nitric acid (40 volumes per cent of 1.42 HNO_3), quickly and thoroughly washed, and immediately immersed in the $HgNO_3$ solution.[1]

The first appearance of cracking may be noticed under the solution by the disappearance of the slight coating of mercury on the surface, showing yellow lines of brass. It may be possible that this amount of mercury dropped into the opening crack. The yellow line, however, is covered by a bright deposit of mercury after the crack has fully developed. Some free acid accelerates all mercury solutions. Some concentrations of mercuric chloride plus hydrochloric acid give a dull to black coating of mercury which veils any early cracks. They also act slower.

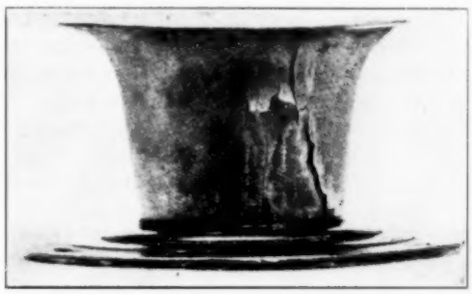

FIG. 5. SEASON-CRACKS IN MOUTHPIECE OF KLAXON HORN

Whereas corrosion cracking was very easy to induce rapidly in the cups, none appeared after the cups had been annealed 30 min. at or above 370 deg C., whether the cups had been made from a fully annealed brass strip or from the same brass strip after it had been hard rolled to Brinell 135. Spun cups were held for one year at 100 deg. C. continuously, and others on alternate days at room temperature, yet they did not break. These same cups broke in a time only slightly longer than the originals after a mercury immersion. It seems therefore that moderate temperature is not in itself sufficient to induce season-cracking, nor are the internal stresses

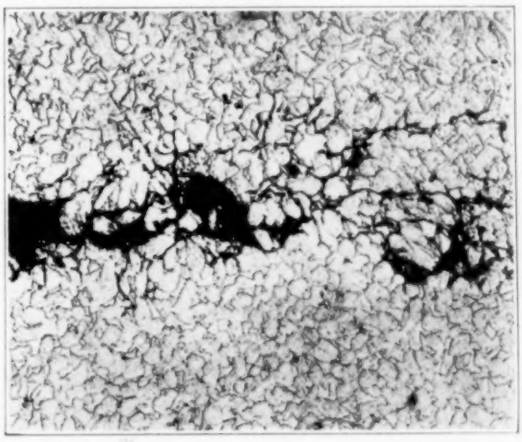

FIG. 6. SEASON-CRACKS IN 60:40 BRASS, FOLLOWING AN INTERCRYSTALLINE PATH. × 100

[1] 1 g. $HgNO_3.H_2O$ crystals plus 1 c.c. 1.42 HNO_3 made up to 1,000 c.c. with distilled water. Solutions having ten times this concentration will cause a crack in a few seconds in a badly strained brass.

responsible for the phenomenon relieved to any extent at the temperature of boiling water.

Cups made from both soft and hard brass strips and soft (60 Brinell) 96:4 phosphor bronze all crack under various reagents after the light pickling described above. The nature of this induced cracking is very similar if not identical to season-cracking.

Of a number of substances tested, including strongly corroding reagents such as nitric acid, hydrochloric acid, nitrogen peroxide and sulphur trioxide in damp air, none produced cracks except ammonia, ammonium nitrate and mercury deposited from solutions of mercury salts, although the trials were prolonged to severe corrosion and pitting. Mercurous nitrate tests on corroded specimens free from cracks at the conclusion of prolonged exposure to other reagents demonstrated the continued presence of severe internal stresses. Unstressed cups and other specimens were included in the trials; results showed that season-cracking occurred only when the brass was in a state of internal stress.

The authors reach the conclusion that season-cracking is therefore not induced in stressed brass by the mechanical weakening of the surface because of the irregular removal of metal by corrosion, but is brought about by the specific acton of certain chemical substances, of which ammonia, its compounds, and mercury are known examples. A number of highly-stressed spun cups have been kept in atmospheres of ordinary purity for four years, yet not one has cracked, a fact which suggests that season-cracking of stressed brass is never "spontaneous," but can only be induced by chemical action of the kind indicated.

A damp mixture of ammonia gas and air, or strong ammonia solutions induce cracks in stressed brass very rapidly; cracks are formed at an early stage in the corrosion in some cases no corrosion is apparent. The action of dry ammonia gas is much slower.

Relation to Fire-Cracking

In order to discover whether season-cracking had much in common with so-called fire-cracking, various

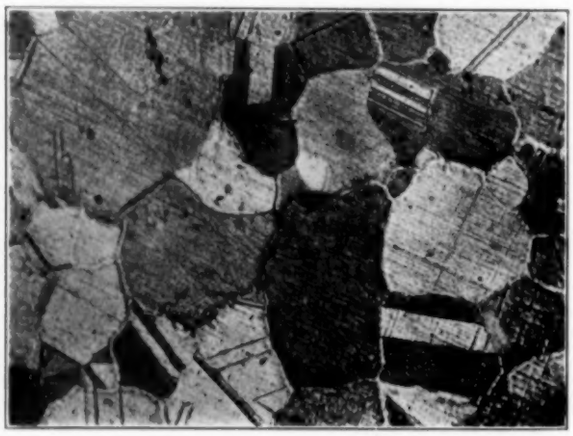

FIG. 7. FIRE-CRACKS IN 70:30 BRASS PRODUCED BY RAPID LOCAL HEATING OF A SPUN CUP. × 100

methods of unequal heating were tried, such as dipping part of a cup in a salt bath at high temperatures, or placing a cup in a hot furnace. The only way in which cracks were produced was by impinging a blow pipe flame at one point of the cup. Fig. 7 shows the intercrystalline character of cracks produced in this way.

Strips of 70:30 brass and of pure copper of various Brinell hardness from cold-rolling were pickled and immersed in the mercury solutions, then removed and stored in tight chests to prevent evaporation of the mercury. After a longer or shorter time the strips were pulled in a tensile machine. The soft specimens had strength and ductility greatly lowered and the fracture changed from fibrous to fine crystalline. As the hardness of the original strip increased, the strength after long contact with mercury seemed to be less affected and at Brinell 183 the strength and elongation (the latter of which is naturally low in such condition) are but slightly lowered, except in some cases after storage for three months. In other words, cold-worked strips were far less damaged than soft metal.

Strips stored over 0.880 ammonia in air suffered a progressive decrease in strength and ductility with the time of exposure in all hardnesses. After long exposure the material can be crumbled in the fingers.

Mechanism of Cracking in Mercury

The nature of some of the breaks suggested that the mercury had merely a surface effect on unstressed test-pieces, so another series of test-pieces, treated in the same manner, were broken by loading them at different rates. The effect of rate of loading was very marked when testing annealed brass: the test-piece loaded in forty-five seconds giving a maximum stress of 20,000 lb. per sq.in., with 23 per cent elongation, while the test-piece loaded in twenty-five minutes broke at 10,600 lb. with 7 per cent elongation. It appeared that free mercury on the surface penetrated the cracks formed in the skin at relatively low stresses, and if sufficient time is allowed, the mercury penetrates through the brass by the gradual extension of cracks into which it flows.

In view of these results it was thought that impact tests on notched bars might throw some light on the depth to which the weakening effect of mercury and of ammonia penetrates in unstressed brass. In none of these tests was the energy absorbed by breakage affected to any marked extent by the mercury or ammonia treatment, the figures remaining approximately constant throughout each series. They confirm the view that in unstressed brass the embrittling effect of mercury or ammonia penetrates only to a comparatively shallow depth even after long exposure, but it will be seen that the depth to which the weakening effect can penetrate is decidedly greater with the latter.

If test-pieces treated in mercury were allowed to stand for seven days and then cleaned of mercury by holding them at 200 deg. C. for forty-eight hours, they had exactly the same tensile properties as the untreated bars.

In order to find the minimum stress which would induce fracture under mercury treatment, a pickled test-strip was given a certain load, then swabbed with the 1 per cent mercury solution for five minutes. The pieces had a hardness of 60 to 170 and thickness up to 0.1 in. No breaks occurred under a stress of 12,000 lb. per sq.in., prolonged fourteen days, which figure may be regarded as the minimum stress which induces accelerated cracking by mercury treatment.

Accelerated Cracks Are Intercrystalline

Some test-pieces were strained and then annealed so as to be made up of a few very large crystals. Crystalline boundaries were then marked by etching or by pencil marks, and the pieces then exposed to mercury or ammonia. After testing in tension the fractures in all

cases were certainly intercrystalline. When fracture was induced by ammonia, the fractured surfaces were accompanied by a characteristic iridescent tarnish; the ammonia seems actually to penetrate the brass. On the other hand, if mercury were taken from the surface of the test-pieces, even after sixty days' exposure, the strength and elongation were reduced approximately 40 per cent, but the fracture was fibrous and entirely different from the intercrystalline nature of the other fractures. It was also absolutely free of mercury, suggesting strongly that the penetration of mercury took place during and not before loading. Furthermore, individual crystals from these broken test-pieces were cleaned of mercury on the surface and very delicate chemical tests showed no mercury (or at least less than 0.00002 g.) in the body of the crystals.

Studies on the amalgams formed by immersion of brasses in mercury showed that during early exposure to mercurous nitrate mercury is replaced in solution by copper and zinc in practically the same ratio as these two elements are contained in the brass. However, immersion in mercury for 320 days gives a preferential corrosion of zinc. It appears that zinc diffuses through the liquid mercury bath and oxidizes on the surface, being replaced by zinc from the alloy. This gives a pitting effect, but there is still no penetration of the mercury into the solid alloy. The disappearance of mercury from the surface of brass in time is due to evaporation of the mercury rather than penetration into the metal. On the other hand, actual separation of the crystals occurred in unstressed brass after sufficiently prolonged action by ammonia.

Influence of Composition

Stressed zinc-copper alloys do not crack under the action of mercury or ammonia if the zinc content is below about 6 per cent; the higher the zinc content the more readily does cracking occur. The authors are convinced that the action of mercury and ammonia is a trustworthy index of the liability of season-cracking, and therefore they would not expect season-cracking in copper or in its alloys with small percentages of zinc. The results of extensive trials with 70:30 brass containing small amounts of manganese indicate that these alloys when stressed crack quite readily or more readily than pure 70:30 brass when submitted to the action of mercury or ammonia. Cracks have also resulted after atmospheric corrosion. Therefore, no indication was found that the presence of manganese reduces the liability to the formation of season-cracks.

Stressed phosphor-bronze is cracked by mercury or ammonia, though much less readily than brass, and may possibly be subject to season-cracking if the conditions are sufficiently severe, but no example of season-cracking of phosphor-bronze in service has come under notice.

Summary of Facts

Corrosion of the surface and sometimes of the walls of the cracks is frequently associated with season-cracking, but corrosion effects are not always visible.

Season-cracking may occur in brass coated with continuous protective layers, such as lacquer.

Nickelplating is probably completely effective in preventing season-cracking, if a sufficient and continuous coat of nickel is secured.

Highly stressed articles, capable of developing season-cracks in certain conditions, may be kept for years in reasonably pure atmospheres without showing any sign of cracking, and there appears to be no reason to expect the development of cracks so long as the condition of the surrounding atmosphere does not change.

Some agency in addition to the presence of initial stress appears to be necessary for the development of season-cracks.

Corrosion does not necessarily favor the development of season-cracks in stressed brass. Very severe corrosion and pitting caused by the prolonged action of various acids and other corrosive agencies had no cracking effect on stressed brass liable to develop season-cracks in other circumstances.

Ammonia has been detected in a water extract of slightly corroded fractures caused by season-cracking in brass etched by atmospheric action only. Reason was found to suspect the presence of small amounts of ammonia in the atmosphere in which the specimens were stored.

It is probable that traces of ammonia in the atmosphere are an important agency, and possibly the main agency, inducing season-cracking of stressed brass.

Ammonia appears to have a specific and selective action upon the intercrystalline material of brass, weakening it sufficiently to cause cracking if in tension. Mercury has a similar but more rapid action.

The cracks produced in stressed brass by mercury or by ammonia are of the same intercrystalline type as season-cracks.

Season-cracks and the similar cracks caused by mercury or ammonia always begin in surface layers which are in tension.

Prevention

The important practical question of the prevention of season-cracking by the removal of initial stress has been previously dealt with by the authors.[2] A suitably controlled low-temperature annealing which will remove stress sufficiently to insure freedom from season-cracking with little or no effect on the hardness appears to be the most effective safeguard against failure by season-cracking and might well be applied to all brass articles made by cold-work operations capable of inducing permanent internal stress.

The wide divergences in composition, structure and physical condition of brass articles which have failed by season-cracking, together with the ease with which stressed brasses of very different compositions or of the same composition but differing in structure may be made to develop "season-cracks" by ammonia treatment, suggest that within the limits of, say, 25 to 45 per cent zinc little improvement in resistance to season-cracking is likely to be obtained by changes in composition or treatment if the state of initial stress is not affected. The apparent advantages of harder-worked brass in resisting season-cracking is largely discounted by the higher stresses which are likely to exist in harder brass if steps are not taken to remove them.

Cold-work operations do not necessarily leave high internal stresses in the worked article. Many objects in which the hardness has been greatly increased by cold-work are not internally stressed. Operations may to some extent be controlled to avoid the development of internal stress even when the maximum hardness is necessary, but as a rule it is simpler and safer to remove internal stress by a final low-temperature

[2] H. Moore and S. Beckinsale, "Removal of Internal Stress in 70:30 Brass by Low Temperature Annealing," *J. Inst. Metals*, 1920 I, vol. 23, p. 225.

annealing than to avoid its development in the cold-working operations. Spinning appears always to produce some degree of internal stress.

It is obvious that stresses present in brass cannot exceed the yield point (regard being paid to the raising of the yield point which may have been brought about by local or general overstrain), and for this reason it is probable that in practice soft brass is unlikely to fail by season-cracking, since the stresses which can exist in it are low. Season-cracking has, however, been frequently observed in brass only slightly hardened by cold-work, but no example has yet come to notice in fully annealed brass.

The distribution of hardness has no necessary influence on internal stress, and cold-work operations which develop a high degree of hardness in one part of an object and leave other parts soft do not necessarily result in severe internal stresses, although they may sometimes induce them. In general it may be stated that internal stress is largely independent of hardness or distribution of hardness, with the reservations that when internal stress arises it is usually developed by operations which at the same time increase the hardness, and that the harder the material the higher is the maximum stress it is capable of sustaining without yielding.

Relation to Amorphous Theory

It is considered by the authors that this study of season-cracking and of the action of mercury and ammonia on stressed brass affords strong support to the hypothesis of an intercrystalline material differing essentially in its properties from the crystals themselves. For example, in the case of a pure alpha brass the intercrystalline material appears to be attacked by ammonia or by mercury much more rapidly than the crystals. The mercury probably alloys with the intercrystalline material, forming a mechanically weak alloy, while ammonia forms a chemical compound possibly of the nature of a cupramine. The apparent presence of an external layer on spun cups and on other cold-worked articles which retards the intercrystalline weakening action of both mercury and ammonia is an interesting confirmation of the view that the intercrystalline material is similar in its properties to the amorphous film produced by surface flow. The operation of spinning would be expected to produce a very definite surface film of Beilby's amorphous phase, and possibly, in addition, a thin lower layer of very severely deformed material containing a high proportion of amorphous phase. If the amorphous material is more capable of combining with or absorbing ammonia or mercury than the crystalline material, it might be expected to exercise some protective action, since the mercury or ammonia would be unable to act on the boundaries of the crystals below until the surface layer had become "saturated." The more rapid apparent disappearance of a thin mercury coating from the outer surface of a spun cup, in comparison with a similar cup from which the flowed surface layer had been removed by pickling before mercury treatment, would confirm this suggestion. The "disappearance" of the mercury coating was probably due in part to absorption of free mercury by the amorphous material in the surface layer. This applies to very thin coatings only; thicker deposits do not disappear except by volatilization, and there is little or no diffusion of mercury to an appreciable depth in brass.

The greater resistance of hard-worked brass to the intercrystalline weakening action of mercury or ammonia may be explained by the much larger proportion of amorphous phase, much of which is assumed to exist within the deformed crystals. The capacity of hard-worked material for absorbing mercury or combining with ammonia should be much greater if the view be adopted that the amorphous material plays the chief part in such reactions. Since the amorphous phase is much more uniformly distributed in cold-worked brass, the selective weakening action is less concentrated at the intercrystalline surfaces. The more severe the cold-work the less should be the selective action at the crystal boundaries, and this is borne out by the diminished intercrystalline weakening as the hardness increases.

It does not appear to be necessary to ascribe peculiar mechanical properties to the intercrystalline substance in order to explain the phenomena of season-cracking, and the authors are unable to find in the results of their work any evidence indicating that season-cracking is the result of viscous flow of the intercrystalline cement. The undoubtedly intercrystalline character of season-cracks in brass appears to be fully explained by the selective weakening action of a chemical substance on the intercrystalline material. In this particular the authors' view of season-cracking in brass differs from that of Rosenhain and Archbutt,[3] although there is agreement in so far as their explanation is also based on the assumption of an intercrystalline material probably identical in its properties with Beilby's amorphous phase found in surface films.

Calcium Silicide as a Deoxidizer

As a deoxidizing agent, calcium silicide, a compound now being manufactured in large quantities in France, is said by the *Ironmonger* to be rapidly gaining in popularity, especially in connection with electric-furnace steelmaking. Calcium silicide, which is a hard, bright, metallic body somewhat similar to ferrosilicon, dissociates when added to the molten metal, and the elements combine with the oxygen present in the bath of metal, and then recombine as calcium silicate, which, as in the ordinary reactions of slag formation, rises to the top. The reaction is a very vigorous one, and the energy liberated in the form of heat when the silicide decomposes is sufficient to bring up appreciably the temperature of the bath of metal. Thus the compound acts not only as a deoxidizing agent, but also as a means of bringing up cold heats to a proper pouring temperature. Another function attributed to calcium silicide is that of a desulphurizer. Under the conditions of the electric-furnace process an appreciable reduction in the sulphur content is said to take place. Its most marked advantage, however, is that it deoxidizes without leaving any harmful inclusions in the metal, and thus insures greater soundness. Calcium silicide, which, though hard, can be readily reduced to powder, gives the best results when added to the molten metal in small quantities, and in this connection the method of inclosing small amounts of the deoxidizer in paper bags and completely burying each one in the ladle of metal is found to be most convenient. For purposes where the carbon does not exceed 0.30 per cent carbon, the best results are said to be obtained by the addition of 10 to 20 oz. of calcium silicide to the ton of metal, while for metal containing more carbon about 30 oz. of silicide to the ton is necessary.

[3] "Intercrystalline Fracture of Metals Under Prolonged Stress," *Proc. Roy. Soc.*, 1919, No. A674, p. 55.

Soldering Fluxes

By A. A. Ladon

THERE probably is no operation more commonly used than that of soldering. Almost every manufacturer, shop, garage, power plant, etc., finds everyday use for this process, yet the literature shows an almost absolute lack of information on the subject. As far as the writer's search revealed, there is no published technical or even semi-technical information. The explanation of this may be that the operation is considered too commonplace to deserve study. But this is not the case; a careful and complete investigation would unquestionably yield valuable results.

There are two forms of soldering—hard and soft. Hard-soldering refers to operations requiring a comparatively high temperature, such as brazing and silver-soldering. Passing mention only will be made of hard-soldering, for the purpose of this article is a consideration of soft-soldering. In brazing, the commonly used flux is borax, from which the water of crystallization has previously been driven. A slight amount of ammonium chloride is often added to the powdered dry borax. A widely used brand has the welding materials already mixed, which consists of powdered brass and borax. The brass used has a high percentage of zinc, so that when it melts on the weld the zinc partly volatilizes, leaving a brass of such composition as to give maximum strength.

Soft-soldering is by far the more commonly used. The most satisfactory solder for general purposes contains equal parts of lead and tin and is known to the trade as "half and half." The temperature used is that merely high enough to heat the parts to be soldered to the flowing point of the solder.

These considerations are fundamental and are given merely to bring to one's mind the operations which make necessary the use of soldering solutions.

Soft-Soldering Fluxes

There are many types of soft-soldering fluxes on the market. The old and still commonly used flux is "cut" muriatic acid. Zinc is added to the acid until action ceases. Then the acid is ready for use. The active material is the zinc chloride formed. However, the action of the acid on the zinc is never complete, there always remaining free acid. This naturally makes corrosion bad unless all of the fluid is carefully washed off of the completed work. To lessen corrosion, commercial zinc chloride salt is often used, and while it is less corrosive than acid, still it excites corrosion markedly.

There are many commercial materials on the market known as soldering salts, the active material of them all being zinc chloride. For use, the salt is commonly dissolved in water. Alcohol is a better solvent, for it evaporates more quickly, and does not "spatter" so much.

The corrosiveness of zinc chloride made marketable the various "non-corrosive" fluxes on the market. Unfortunately all of the so-called non-corrosive materials are corrosive in a degree and unless carefully washed away excite corrosion.

The non-corrosive—so called—fluxes are made by mixing zinc chloride in a material not an electrolyte —such as vaseline. They can be mixed by stirring or running them through a common "buhr-stone." A very small amount of water added to the mixture and thoroughly incorporated with it has the effect of stiffening it. However, this is better accomplished by the addition of paraffine or the use of a higher melting-point vaseline. Ammonium chloride is often added.

Another useful form of soldering flux is in stick form. The chloride is "dissolved" in the paraffine and melted into shape.

From these statements, one might conclude that zinc chloride is the only active soldering flux. It probably does the quickest work, but there are many others, each with their advantages.

Phosphoric acid, lactic acid, tallow, rosin, glycerine, depending on the metals to be soldered, are good. Rosin is the only flux the writer has been able to find that is really non-corrosive. For ordinary work, it is used dissolved in alcohol. It is slow in action, and the solder does not flow well over the work. Tallow is corrosive on certain metals. Glycerine with slight addition of zinc chloride is very good on german silver.

There are probably a very large number of materials that could be used for fluxes, but zinc chloride—as corrosive as it is—seems to "hold the field."

Different Fluxes for Different Metals

Each metal requires a different flux to obtain the best results. On flat work a different flux should be used than that used on concave or convex surfaces. Each soldering problem has a particular flux that works the best.

The fact that the same flux does not work to advantage on all types of surfaces of even the same metal leads the writer to believe that the present conception of the function of a flux is not wholly correct.

To solder, the surfaces must be clean. Clean surfaces rapidly oxidize and present a very thin coat of oxide. The present theory is that the flux dissolves the oxide film so that the molten solder can alloy itself to the metal, but that is disproved by the fact that slowly oxidizing metals like copper or brass scratched and cleaned carefully in an atmosphere of nitrogen cannot be well soldered, even in that non-oxidizing atmosphere, without a flux.

A drop of molten solder placed on a clean metal remains in almost spherical form. The moment a flux is placed on that drop, the solder flattens out. This indicates that the action of a flux is to decrease the surface tension of the molten metal. This change of surface tension and the solution of the metallic oxides formed are the evident dual purpose of the flux.

There should be a means of decreasing the surface tension of molten metals other than by the use of a corrosive material, and it is the purpose of this article merely to present the possibilities of research on this subject.

Quinine Culture in the Philippines

The feasibility of an extensive culture of quinine in the Philippines is emphasized by Dr. Elmer Merrill, director of the Philippine Bureau of Science, in answering to an inquiry from Ely Lilly & Co. of Indianapolis, manufacturing pharmacist. Dr. Merrill points to the available big areas in Luzon and Mindanao Islands that are highly adapted for quinine culture. At present there is one small quinine plantation in Baguio. This plantation is under the supervision of the Bureau of Forestry and the results obtained from its operation indicate the success of the industry. Climatic conditions in the Islands are believed to be favorable.

Book Reviews

SILVER, ITS INTIMATE ASSOCIATION WITH THE DAILY LIFE OF MAN. By *Benjamin White;* 144 pp., one chart, illustrated. London: Sir Isaac Pitman & Sons, Ltd. Price $1.

Silver is discussed as a commodity. In the first part of the book the author reviews its mineralogy, mining, metallurgy and marketing, and describes some of the early and modern mine fields. In the second part he discusses the silversmith's art at different periods, and enumerates many of the articles and ornaments into which the metal is manufactured. This portion of the work contains an interesting account of Indian industries, and a review of the evolution of British coinage. The third and last part of the volume is devoted to a discussion of the utility of silver as money, past and present, with dissertations on Indian currency and Chinese monetary problems, and the author's views of the present position and the future prospects of silver as money. The text is illuminated by numerous halftone illustrations, and is amplified with appropriate statistical tables and charts, the one showing the price fluctuations in London since 1832 being of special interest to students of the silver market.

The reader, if a student or engineer, is apt to gain a rather unfavorable impression of the book in the earlier pages, because they cover in an incomplete manner much ground with which he is already familiar. However, as he proceeds faithfully into the second and third parts of the book, his impatience is replaced by interest in the light of the discussions of monetary problems, if these subjects entertain him. To the non-technical reader, or layman, the work is likely to be quite interesting, and its perusal will leave him with entertaining impressions and additional information. H. J. WOLF.

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OFFICIAL AND TENTATIVE METHODS OF ANALYSIS OF THE ASSOCIATION OF OFFICIAL AGRICULTURAL CHEMISTS. Compiled by the *Committee on Revision of Methods* (R. E. Doolittle, Chairman, B. L. Hartwell, G. W. Hoover, A. J. Patten, A. F. Leeker and W. A. Withers). Revised to Nov. 1, 1919. Published by the Association of Official Agricultural Chemists, Washington, D. C., September, 1920, xii + 417 pp. 18 fig. Price, $5.

The present volume is the latest revision of the famous "Methods of Analysis of the A. O. A. C." which were originally published as Bulletins 46, 65 and 107 of the Bureau of Chemistry, U. S. Department of Agriculture, and more recently (1916) as a supplementary part of the *Journal* of the Association of Official Agricultural Chemists. All of the earlier editions have been out of print for some time, so the present volume appears at a very opportune moment.

The methods of analysis are given for Fertilizers, Inorganic Plant Constituents, Waters, Tanning Materials, Leathers, Insecticides and Fungicides, Foods and Feeding Stuffs, Saccharine Products, Food Preservatives, Coloring Matters in Foods, Metals in Foods, Fruits and Fruit Products, Canned Vegetables, Cereal Foods, Wines, Distilled Liquors, Beers, Vinegars, Flavoring Extracts, Meat and Meat Products, Dairy Products, Fats and Oils, Spices and Other Condiments, Cacao Products, Coffees, Teas, Baking Powders and Baking Chemicals, Drugs, Soils, followed by seventy-eight pages of reference tables. The book closes with a good index.

The reviewer is in hearty accord with the statement in the preface: "It may be stated without reservation that more elaborate and painstaking effort has been expended on this collection of analytical methods than upon any other set of similar methods in the field of chemical science." Extreme conservatism is practiced in the adoption of a method as "official." This is well illustrated by the fact that the determination of amino nitrogen by Van Slyke's method is still (p. 216) a "tentative" method in spite of the fact that the ease of manipulation and the accuracy of the method have been established beyond question. On the other hand, this same conservatism causes the retention of statements in "official" methods which are questionable. For example, on page 72, "amido nitrogen" undoubtedly refers to "non-protein" nitrogen and not to the $CO\text{-}NH_2$ grouping alone; likewise "amino" nitrogen in paragraph 12, page 168, does not refer to nitrogen in amino groupings, but to "non-protein" nitrogen.

It is an easy matter for a reviewer to find minor faults in a book. The virtues of the present volume are, however, sufficient to entirely overshadow any faults. The methods are "official" for all agricultural products, especially for all regulatory work where the possibility of judicial proceeding is always present. In court cases these methods are accepted as standard and binding. It is only natural, therefore, that the procedures outlined in these methods should be followed in the "food analysis" courses of our agricultural colleges and universities. The book is well printed on good paper and durably bound in tan buckram. It is such a necessary companion to the food and agricultural chemist that it is to be hoped arrangements have been made so that it will not again be out of print for any considerable period of time. R. A. GORTNER.

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THE OPEN HEARTH—ITS RELATION TO THE STEEL INDUSTRY—ITS DESIGN AND OPERATION. By *Victor Windett.* Pp. 378; 8½ x 11 in. New York: United Publishers Corporation. First Edition, 1920. Price $7.50.

This book was originally issued by the Wellman-Seaver-Morgan Co. of Cleveland, Ohio, with no author's name given on the title page. A brief introduction led to the assumption that it is the work of engineers associated with the Wellman-Seaver-Morgan Co., since it states that "the facts given are based largely on their working data . . . constantly enriched by intimate exchange of experiences and records with the best practicing steel makers of the present time." Shortly after publication, however, the title page was changed, showing Victor Windett, one of the company's engineers, as author, and United Publishers Corporation as publisher.

In view of the great influence which one of the founders of the company—the late Samuel T. Wellman—had upon the early introduction and adaptation of the open hearth to the American steel industry, and the excellent labor-saving machinery which has been perfected and marketed by the company, notably the charging machine and ingot manipulator, the Hewlit unloader and the car dumper, one opens this rather imposing book with a feeling that it will undoubtedly contain much information of value to those engineers who have felt that the open-hearth furnace has not progressed as it should in recent years. Operators have apparently been so busy modifying the lines of their furnace to suit changes in fuel, refractories and charges that they have not given the attention to fundamentals which underlie rational improvements in construction. Designing engineers have seemingly been content to construct furnace accessories to fit a building rather than *vice versa*, as long as checkerwork flues, and valves not too far different in size from those in neighboring plants could be tucked into the cellar and kept above ground water. Little material on the essentials of furnace design is available in literature, but surely the Wellman-Seaver-Morgan engineers have it; and a book from them should become a furnace constructors' Bible.

Examination of the book proved a disappointment. Little or no detailed information on the fundamentals of furnace design is included. Even the generalities—often elementary—are confined almost exclusively to furnaces built to that company's design. Other widely known and excellent modifications are dismissed with a short paragraph.

It collects together a very large number of excellent photographs and line drawings, the latter printed in such a manner as to simulate blue-prints. While these drawings are mostly general drawings, many of them contain details which can be put to much use by the expert furnace draftsman content to follow the rule of thumb. A great amount of data has also been brought together on

acceptable operating details, as well as conventional furnace sizes. The book is particularly remiss, however, in discussing why such conditions exist, or what might be expected if these furnace lines were altered, either by design or accident.

On page 97 may be read the following words: "The proper planning of the gas and air ports is an important part of a furnace design. This insures a combustion so controlled as to throw into the bath a maximum of heat by radiation and combustion." How are these important objects to be attained? On page 123 are found sixteen lines on this subject. After noting the scouring action of hot, dusty gases, the book states: "Good practice requires the delivery of the air toward the top of the furnace. This insulates the roof from the intense heat of combustion and prevents excessive oxidation of the metal of the charge, for the oxygen-absorbing flame interposes. The slope of the ports should be such as to secure an intimate mixing of the air and gas at a height of about 3 ft. above the bath." On page 97 the following statement is also made: "Admission of fuel should be directed to obtain complete combustion without the flame impinging upon the roof, bath or ports at the opposite ends." That is about all. The slope and dimensions of the ports may be scaled from some of the blueprints. But is it not possible to figure the path of a certain current of burning gas in a furnace at various temperatures, so that before the furnace is built it would be possible to state whether the flame actually could be forced down so as to "lick" the bottom, as is necessary to "burn it in," and so the flame could lick the bath to provide the maximum heat transfer between flame and molten material? Some of the most astute furnace-men in the country now realize that velocity of air and gas, proper atomizing of fuel or its early and intimate mixture with the air for combustion are major factors in approaching the ideal heating conditions: the earliest possible combustion in the shortest possible time. One might fairly expect a discussion of such tendencies in a book of this kind.

Again, regarding the design of regenerators. The book states on page 124 that in many cases an allowance of anywhere from 65 to 140 cu.ft. of regenerators per ton of rated furnace capacity is needed. With this tremendous difference in practice, one would expect that scientific design would help to obtain an approximate idea as to which extreme was more nearly correct.

The author has the following general statement to make:

1. "As many checker bricks should be put into the chambers as possible to allow storing a maximum amount of heat from the waste gases without an undue increase in gas velocity." What, for instance, is an "undue increase in gas velocity"?

2. "A maximum of surface should be exposed." Could not several arrangements of brick be illustrated showing the amount of surface exposed as varied by the method of packing? Should checker brick be bought which have the best chance for subsequent cleaning and re-use, or brick which have the best ratio of surface to mass?

3. "The disposition of the checkers should be such as to have an intimate contact with the gases and air." Does this mean that there is to be a maximum of interference so as to produce the most eddy currents?

4. "The design must have a uniform volumetric capacity for the flow of air and gases through the various openings in the checkers." Elaboration of this sentence would doubtless clarify its exact meaning.

5. "The material used and the size and structure of the checker bricks must be adequate to carry the superimposed load on them at high temperature." How high, for instance, would a checker brick have to be before it would squat of its own weight when heated uniformly to 1,000 deg. C.?

6. "Means for securing increased velocity of flow at salient points so as to avoid flue dust deposits. This dust glazes over the brick surface and destroys their thermal qualities, in addition to cutting down the cross-section of the passages." The reviewer is of the opinion that most of the "dodges" for securing or controlling the flow of hot gases through a checkerwork are of very indifferent value. If vertical, well-insulated stove-like checkers would be built, instead of the long low ones now common, so that the hot gases could travel from top to bottom and the air to be heated from bottom to top, a checkerwork not grossly misbuilt tends to balance itself; that is to say, the hot gases seek out the passages, where they can give up their heat at the maximum rate, and on the other hand the cold gases favor locations where they can absorb heat at the maximum rate. In other words, if they are given a chance by correct design, the hot gases reach the cold spots, and the cold gases reach the hot spots. Could any better automatic device be imagined? E. E. THUM.

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INTRODUCTION TO GENERAL CHEMISTRY. Text Book, by *Herbert N. McCoy* and *Ethel M. Terry*. 128 illustrative figures, 629 pages subdivided into 33 chapters. New York: McGraw-Hill Book Co., 1920. Price, $3.50.

The authors state in the preface, "The choice and arrangement of topics in the earlier part of the book depart noticeably from the familiar order."

The reviewer believes that the reader of this review will best understand the comment when he has a clear idea of the general arrangement of the subject matter. It is for this reason that the "Table of Contents" is given: Chapter I, Introduction—Laws of Gases; II, The Burning of Substances—Oxygen; III, Pure Substances—Elements; IV, The Law of Definite Composition; V, Symbols and Chemical Formulas; VI, Chemical Equations; VII, Acids, Bases, and Salts—I; VII, Water and Solutions; IX, Acids, Bases and Salts—II; X, The Kinetic Theory of Matter and the Molecular Hypothesis; XI, The Atomic Hypothesis and Atomic Weights; XIII, The Halogens and Their Compounds with Hydrogen and Metals; XIII, Chemical Equilibrium; XIV, Hydrogen and Oxygen; XV, Oxidation and Reduction; XVI, Heat and Energy; XVII, The Ionic Hypothesis; XVIII, Applications of the Ionic Hypothesis; XIX, Applications of the Ionic Hypothesis: Reactions Involving Changes of State; XX, Electrochemistry; XXI, Nitrogen and Ammonia; XXII, Nitric Acid and the Oxides of Nitrogen; XXIII, Phosphorus and Its Compounds; XXIV, Sulphur and Its Compounds; XXV, Carbon and Carbon Compounds, Organic Compounds—I; XXVI, Organic Compounds—II; XXVII, Theory of Dilute Solutions; XXVIII, Disperse Systems; XXIX, The Atmosphere and Related Topics; XXX, Some Additional Elements and Their Compounds; XXXI, Classification of the Elements. The Periodic System; XXXII, Radioactivity and the Nature of Matter; XXXIII, Metallurgy.

It is only necessary to glance at this "Table of Contents" to realize that the claim of the authors is well founded. A statement in the introduction further defines the authors' viewpoint—viz., "It is to be assumed that the student taking up chemistry has had at least a one-year high school course in physics." In reading the text, however, the reviewer did not feel that a beginner in chemistry using this text would be so much handicapped by lack of such a course. The authors exercise considerable care in defining any terms or units used, many of which should be understood by a student who had had his assumed course in physics—e.g., in Chapter I the gas laws are carefully developed.

When one reads the text carefully and notes that Chapter VI ends on page 56 and that the student has made an acquaintance with many chemical reactions, the rôle of substances—elements and compounds—in reactions, and the quantitative significance of the chemical formula without being told anything about atoms and molecules, it is quite evident that the first part of the book is a departure. When one looks for his familiar friends oxygen and hydrogen, and finds they are not introduced until Chapter XIV, page 176, he is again struck with the new order of things. This might suggest looking for other old friends, e.g., the metals and their salts. When they are found not only will the authors be given credit with originality for "order and arrangement" in the first part of the book but even more so in the latter part, for if one is conscientious enough in his search he will find them very briefly considered in Chapter XXX among "Additional Elements and Their Compounds" and in Chapters XXXI and XXXIII.

Some other striking departures may be noted. Acids,

bases and salts are considered without reference to the dissociation theory, which follows in a later chapter. Although the gas laws are considered in the first chapter, the kinetic molecular hypothesis is not introduced until Chapter X.

Disregarding our individual views with respect to the arrangement of topics, it must be admitted that the authors have presented the topics in a clear and teachable manner. Chapters IV, V, VI, XIII, XVI, XVIII, XX and XXXII are especially well written. Chapters XXVII and XXVIII give special consideration to important elementary topics hardly mentioned in the ordinary introduction texts in chemistry. The book closes with a very well-arranged chapter on metallurgy.

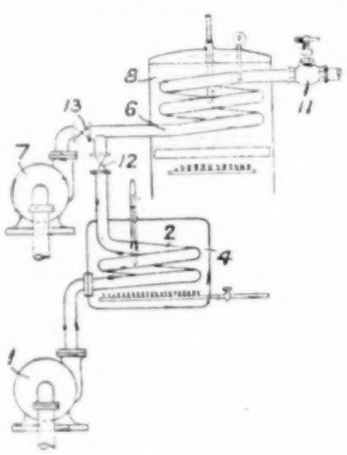
When one follows the arrangement of topics and considers the method of treatment, he cannot fail to recognize that the authors have a "philosophy of arrangement" and the courage to present it. CLIFFORD D. CARPENTER.

Recent Chemical & Metallurgical Patents

British Patents

Complete specifications of any British patent may be obtained by remitting 25c. to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Effecting Chemical Reactions Under Pressure.—Liquids, solids or gases which react at high temperatures under pressure are introduced separately or together, into heated pipes wherein the reaction takes place. The figure shows one form of apparatus in which the reacting materials are respectively forced by pumps 1, 7 into the connected pipes 2, 6 which are provided with valves 12, 13 and are heated in the tank 4 and metal bath 8. The outlet of the product is controlled by the valve 11. (Br. Pat. 156,264; not yet accepted; H. SCHELLENBERG, Wadenswil, Switzerland. March 9, 1921.)



Synthetic Tanning Agents.—Synthetic tanning agents consisting of coupled aromatic compounds, coupled aromatic and aliphatic compounds or coupled organic compounds and vegetable tanning agents are converted into aluminum or chromium salts, which also are tanning agents, by treating the free acids or their salts, or mixtures thereof, with aluminum or chromium compounds, or mixtures thereof. According to examples: tar oil is sulphonated and condensed with formaldehyde, the free sulphuric acid is neutralized by potash, and the product is neutralized by aluminum hydroxide; tar phenols of boiling point 185-200 deg. C. are heated with sodium sulphite and formaldehyde solution, the product is acidified by sulphuric acid and the sulphur dioxide boiled off, and the product finally neutralized by chromium hydroxide; a mixture of naphthalene and phenol is sulphonated and condensed with formaldehyde, the product is diluted, neutralized with lime till only feebly acid, filtered and finely neutralized with basic chromic sulphate; creosote oil is sulphonated and condensed with formaldehyde, and the product mixed with chromium sulphate and caustic soda solution until only feebly acid; a mixture of naphthalene and phenol is sulphonated and condensed with formaldehyde, the product is further condensed with tannin and formaldehyde and finally neutralized by potash and aluminum hydroxide; a mixture of 2:6 naphthol sulphonic acid and glucose is condensed with formaldehyde and the product neutralized by chromium hydroxide. The products may be used in tanning, alone or mixed with other tanning agents, by any of the usual processes. (Br. Pat. 156,254; not yet accepted; CHEMISCHE FABRIKEN & ASPHALTWERKE AKT. GES., Griesheim-on-Main. March 9, 1921.)

Tannic Extracts. — Tannin-containing materials (wood, bark or leather) has the tannin extracted by alkali solutions. From the filtered extract the tannin is precipitated as an insoluble metal tannate, which is then decomposed by an acid, such as sulphuric or oxalic. A reducing agent such as a sulphite may be added in the alkali extraction to prevent oxidation of the tannin, or the extraction may be performed in a non-oxidizing atmosphere. When treating sawdust or shavings, any alkali-cellulose formed is precipitated by neutralizing the alkaline extract by an acid, before precipitation of the metal tannate. Br. Pat. 156,653; not yet accepted; Mrs. A. RIALLAND, Reunes, France. March 16, 1921.)

Synthetic Resins.—Synthetic resins, homologous with coumarone and indene resins, are obtained by polymerizing with concentrated sulphuric acid the tar oil fractions from carbolic or creosote oils which boil between 190 and 240 deg. C. and are free from coumarone and indene. The starting material is first freed from napthalene by freezing and then from acid tar oils by extraction with alkali. The products of polymerization are isolated by distillation of the non-polymerized oils; they are useful for the manufacture of varnishes. (Br. Pat. 156,668; not yet accepted; CHEMISCHE FABRIKEN WORMS AKT. GES., Frankfurt-on-Main. March 16, 1921.)

Phenol-Aldehyde Condensation Products. — An initial liquid phenol-formaldehyde condensation product is prepared by the reaction of phenols (phenols, cresols, naphthols) with anhydrous polymers of formaldehyde (para-formaldehyde, trioxymethylene) in the presence or absence of alkaline catalysts; this liquid product is converted into the final insoluble infusible product by addition of liquid organic acids (lactic, acetic formic, ricinoleic, sulphoricnoleic, etc.) or solid organic acids such as oxalic, tartaric, citric, gallic or tannic acid, dissolved in a liquid organic acid together with small amounts of a mineral acid (hydrochloric, oxyacids of sulphur or phosphorus, boric, etc.); the conversion takes place in the cold, or more rapidly on heating. The initial liquid product with the acids added can be used as a varnish, or for glueing together laminæ of wood, wood and fabric, etc. Fillers, such as pumice, sand, glass, emery, asbestos, insoluble mineral bodies, paper pulp, sawdust, cotton, etc., may be incorporated in the mass, or its properties varied by addition of gelatine, glue, naphthalene, rubber, etc. Vessels resisting chemical reagents can be made from the final product, or laminæ or plates thereof can be glued on surfaces by means of the initial product varnish. (Br. Pat. 156,675; not yet accepted; J. BRUHAT, Bois-Colombes, France, assigned to Lorival Mfg. Co. of London. March 16, 1921.)

Vulcanizing Rubber. — Furfuramide and other nitrogen derivatives of furfuryl are used as accelerators in vulcanizing rubber. Several furfuryl derivatives are mentioned in addition to furfuramide, in particular the condensation products of pyromucic aldehyde with ammonia or amines. (Br. Pat. 157,050; not yet accepted; SOC. R. ALLENET & CIE, Deux Sevres, France. March 23, 1921.)

Coating Metals With Aluminum.—In a method of coating iron, steel, copper and other metals with aluminum, the cleaned surface is first coated with linseed or other oil, heated to burn off the oil, and again coated with oil; powdered aluminum, with or without the addition of oil or flux, which may be beryllium nitrate, or of sand or other hard material, is then applied to the surface, and the article is heated to about 1,200 deg. F. After cooling, the oxide which has formed is removed, and the operations are repeated until a coating of the desired thickness is obtained. The surface is finally treated with oil and heated to burn off the oil. A thicker coating of aluminum may be obtained by sweating sheet aluminum on to an aluminum-coated surface obtained as described above. (Br. Pat. 158,010; THOMPSON, LTD., J. THOMPSON and H. E. PARTRIDGE, all of Wolverhampton April 6, 1921.)

Current Events
in the Chemical and Metallurgical Industries

House Committee Approves Appropriations Requested by Hoover

Quite contrary to the usual practice, the Committee on Appropriations of the House of Representatives acceded to the request of the Secretary of Commerce and allowed the full $250,000 requested for export industries. This fund is to be used principally in an effort to assist the twelve chief export industries, to wit: Cotton and cotton goods, paper and paper products, leather and leather products, chemicals (including dyestuffs), heavy machinery and machine tools, electrical goods, automobiles and accessories, lumber and lumber products, jewelry and silver, metal products, vegetable oils and hardware.

In addition, the committee approved the full amounts which Secretary Hoover asked for the Bureau of Standards as follows: Testing structural materials, $50,000; industreal research, including elimination of waste, $100,000; standardization of equipment, $100,000.

These items are included in the second deficiency appropriation bill, which was reported to the House of Representatives on May 18.

Text of Dye Control Title

The complete text of the dye and chemical control title of the emergency tariff bill, as agreed to in conference, is as follows:

TITLE V—DYES AND CHEMICALS

Sec. 501. (a) That on and after the day following the enactment of this act, for the period of three months, no sodium nitrite, no dyes or dyestuffs, including crudes and intermediates, no product or products derived directly or indirectly from coal tar (including crudes, intermediates, finished or partly finished products, and mixtures and compounds of such coal-tar products), and no synthetic organic drugs or synthetic organic chemicals, shall be admitted to entry or delivered from customs custody in the United States or in any of its possessions unless the Secretary determines that such article or a satisfactory substitute therefor is not obtainable in the United States or in any of its possessions in sufficient quantities and on reasonable terms as to quality, price and delivery, and that such article in the quantity to be admitted is required for consumption by an actual consumer in the United States or in any of its possessions within six months after receipt of the merchandise.

(b) Upon the day following the enactment of this act the War Trade Board Section of the Department of State shall cease to exist; all clerks and employees of such War Trade Board Section shall be transferred to and become clerks and employees of the Treasury Department and all books, documents, and other records relating to such dye and chemical import control of such War Trade Board Section shall become books, documents and records of the Treasury Department. All individual licenses issued by such War Trade Board Section prior to the enactment of this act shall remain in effect during the period of their validity, and the importations under such licenses shall be permitted. All unexpended funds and appropriations for the use and maintenance of such War Trade Board Section shall become funds and appropriations available to be expended by the Secretary in the exercise of the power and authority conferred upon him by this section.

Sec. 502. That this title may be cited as the "Dye and Chemical Control Act, 1921."

Would Investigate Dust Explosions

A bill introduced in the Senate provides appropriation of $100,000 to conduct further investigations of dust explosions in industrial plants.

Movement of Chemicals Through Canal

An analysis of the commodities which passed through the Panama Canal during March shows the following, of chemical interest, moving from the Atlantic to the Pacific: Nitrate of ammonia, 1,817 tons; silver sand, 2,492 tons; sulphur, 12,350 tons; caustic soda, 81 tons; chemicals, not otherwise specified, 520 tons. The nitrate of ammonia and silver sand originated in Continental Europe and was consigned to the west coast of the United States. The sulphur originated on the Gulf coast and was consigned to Australia. The caustic soda originated in the British Isles and was consigned to the west coast of South America. The bulk of the tonnage of chemicals not otherwise specified originated on the east coast of the United States and was consigned to the Far East.

Among the commodities moved from the Pacific to the Atlantic were the following: Nitrate of soda, 141,026 tons; camphor oil, 717 tons; chemicals (not otherwise specified) 113 tons; indigo, 2 tons; iodine, 7 tons; arsenic ore, 17 tons; manganese ore, 1,000 tons. The nitrate was destined as follows: east coast of United States, 52,215 tons; British Isles, 22,245 tons; other Europe, 39,465 tons; Azores Islands, 15,524 tons; West Indies, 11,577 tons. The camphor oil originated in the Far East and was billed to the east coast of the United States. The same is true of the chemicals which were not otherwise specified. The indigo originated on the west coast of South America and was sent to Cristobal for orders. The iodine was shipped from the west coast of South America and was destined to Continental Europe. The arsenic ore came from the Far East and was billed to the east coast of the United States. The same is true of the manganese ore.

Inventor of Gasoline From Peat Is Arrested. Charged With Fraud

On application made to Judge Lewis J. Smith at Mineola, L. I., by William H. Doolittle of Woodmere, Louis Enricht, of Farmingdale, was arrested on May 24 and released on $1,000 bail, which he furnished with a certified check. The plaintiff before bringing the action filed a bond with a surety company as evidence of good faith. This action followed a summons and complaint made out by Doolittle, who said that he paid Enricht $1,000 for 100 shares of capital stock in the Enricht Peat Gasoline Corporation.

Through his counsel, Dudley A. Wilson, Doolittle avers that on Nov. 18, 1920, at Farmingdale Enricht represented to him that he had organized a corporation known as the Enricht Peat Gasoline Corporation, of which Enricht was president, and that "he then and thereupon falsely and fraudulently represented that he was the inventor of a process and apparatus capable of producing gasoline for ordinary commercial usage from peat such as is found in and around the village of Farmingdale and various other parts of Long Island."

Enricht came into prominence several years ago when he announced that he could produce gasoline for 2c. a gal. by the introduction of a green ingredient. He had leading manufacturers of cars calling at his place, including Henry Ford, but nothing came of the green gas proposition.

St. Louis Chemical Plant Damaged by Fire

A fire which caused damage estimated at about $50,000 started from an explosion in the first-floor laboratory of the Missouri Chemical Works, Inc., 1501 South Second St., St. Louis, on May 18. The plant, which employs about forty men, has been idle for several weeks and only two men were in the building when the fire started.

Program of National Lime Association Convention

The annual convention of the National Lime Association will be held at the Hotel Commodore, New York, June 15, 16 and 17. The foyer of the convention room will be occupied by exhibits of the National Association and of the Eastern Bureau. Details of the technical program follow:

WEDNESDAY, JUNE 15

Lime Production Problems

10 a.m. Assembly and roll call of member companies. Representatives are invited to make comments on the status and outlook of the lime industry in their home sections.

10:30 a.m. Introductory remarks, President Charles Warner.

10:40 a.m. Some New Features in Limekiln Construction. Richard K. Meade, chemical and industrial engineer, Baltimore, Md.

11:15 a.m. Chemical Control the Key to Kiln Efficiency. W. D. Mount, mechanical and chemical engineer, Lynchburg, Va.

12 m. The Fine Art of Lime-Burning. George B. Wood, president and general manager, Rockland & Rockport Lime Corporation, Rockland, Me.

12:45 p.m. Complimentary buffet luncheon.

1:30 p.m. Luncheon address. Standardization—Government Research and Industrial Development. Dr. S. W. Stratton, director, U. S. Bureau of Standards.

2:15 p.m. Quarry Management With Special Reference to Machine Versus Hand Methods. Irving Warner, plant manager, Charles Warner Co., Wilmington, Del.

6:30 p.m. Banquet.

THURSDAY, JUNE 16

Extending the Use of Lime

9 a.m. Symposium on the Special Properties and Merits of Lump Lime. Speakers to be announced.

12:45 p.m. Complimentary luncheon.

1:30 p.m. Luncheon address. The Business Outlook. Francis H. Sisson, vice-president, Guaranty Trust Co., New York City.

2:30 p.m. Delivering the Goods: The Dealer's Viewpoint. Tom Wright, manager, Building Materials Corp., formerly secretary of New York Station Building, Supply Dealers Association, Rochester, N. Y.

3 p.m. The Dependence of Modern Industry on Research. Arthur D. Little, president, Arthur D. Little & Co., consulting industrial chemist, Cambridge, Mass.

3:45 p.m. Why Is a Soil Chemist? or, Getting Facts About Lime on the Soil. Dr. W. H. MacIntire, soil chemist, Agricultural Experiment Station, Knoxville, Tenn.

4:15 p.m. Lime and Lime: The Plasticimeter Demonstrated. Warren E. Emley, U. S. Bureau of Standards, Washington, D. C.

FRIDAY, JUNE 17

Technical Department Accomplishments and Plans

10 a.m. Construction, L. H. Hart, manager.

10:20 a.m. Chemistry, Dr. M. E. Holmes, manager.

10:40 a.m. Agriculture, J. A. Slipher, assistant manager.

11 a.m. District Bureau Work.

Annual Table of Constants Delayed by Printers' Strike

Owing to delays incident to the printers' strike it has been found necessary to advance the date at which subscriptions at the special reduced rates will be received for the forthcoming Vol. IV of the Annual Tables of Constants and Numerical Data of Physics, Chemistry and Technology. Details concerning this volume, subscription rates, etc., were published on page 853 of our issue of May 11.

Members of the American Physical Society and of the four constituent societies of the Division of Chemistry and Chemical Technology of the National Research Council are entitled to a special discount. Subscription blanks may be obtained by addressing the University of Chicago Press, Chicago, Ill.

Dr. Stieglitz Talks on Electron Theory of Oxidation and Reduction

In delivering one of the best talks that has been made before the Chicago Section of the American Chemical Society Dr. Julius Stieglitz gave an extremely interesting exposition on the electron theory of oxidation and reduction, accompanying his talk with numerous lecture table experiments, at Kent Chemical Laboratory, University of Chicago, on the evening of May 20. His remarks are abstracted in the following paragraphs.

Recent developments as to the structure of atoms have brought more light on the subject in question. In reviewing a series of facts that are perhaps familiar to a great many of the members, we may nevertheless enjoy it again as one would delight in viewing an impressive and familiar landscape. We may deal with the electron as an intra-atomic phenomenon rather than an inter-atomic. Long before the present theories were developed the relation of the electron to oxidation and reduction was almost as thoroughly understood as it is now. By numerous experiments we may illustrate chemical action at a distance. These modern discoveries in regard to the electron have simplified the theory of chemical reaction.

In 1897 J. J. Thomson, the noted British scientist, made a fundamental study of oxidation in its relation to the X-ray tube, finding that the atoms of all elements are made up of electrons and that those which are negative in character have a mass $\frac{1}{1400}$, that of a hydrogen atom. Rutherford later discovered that the positive particles have larger mass than the negative. Electrons on the periphery of the structure are the ones which we are concerned with in oxidation and reduction. Experiments of chemical action at a distance demonstrate that the particles or electrons actually pass through the wire, as evidenced by the electric current. It is readily predicted that in the future many electrical methods will replace others in the accomplishment of oxidation and reduction. Current cannot be passed through a solution without having oxidation and reduction of the solution.

In a quantitative discussion of the subject consider the copper:zinc couple. The tendency of copper to give up its ions may be expressed by 10^{-21}, while a much larger tendency on the part of zinc may be expressed by 10^{17}.

Such tendency on the part of substances to give up ions may be compared with vapor pressure as measured by the wet and dry hydrometer. The difference in temperature in the latter case is the same as the difference in potential in the former. Experiments show that the tendency of copper to give up its ions is not dependent on the concentration of copper in solution but on the concentration of the cupric ion. Activity, then, for oxidation and reduction depends on the concentration of free ions.

To sum up, we find that oxidation consists in the loss of electrons by atoms and that reduction consists in the gain of electrons by atoms. Not only does such action produce current in the wire, but oxidation and reduction may be accomplished by passing ions through the wire to the solution to be treated.

Summer Meeting of New Jersey Clay Workers

The New Jersey Clay Workers Association and Eastern Section of the American Ceramic Society will hold its regular mid-year meeting at Trenton, N. J., with morning and afternoon sessions. It is expected to call the meeting at the Trenton Country Club, as in former years. Prof. George H. Brown, Rutgers College, secretary and treasurer of the organization, is arranging an interesting and instructive program for the day, covering a number of papers on pertinent subjects in the ceramic industry. A large attendance is expected.

Union Bag Plants Closed Down

Plants of the Union Bag & Paper Corporation have been closed down due to walkout of employees, involving about 2,000 men. The newsprint plant of St. Maurice Paper Co., its subsidiary at Three Rivers, Quebec, Canada, employing 600 men, has also been closed. Wage agreements expired May 11.

Mme. Curie's Visit an Inspiration

Public interest in science has been increased immeasurably by the visit of Mme. Curie. This is the opinion of Dr. R. B. Moore, chief chemist of the Bureau of Mines. It has been a special encouragement to research on the part of women. "The American woman," said Dr. Moore, "has been content heretofore to devote most of her study to literature, art and music. As a result of Mme. Curie's visit thousands of women will be encouraged to take up the serious study of science. The country will derive great benefit from directing the feminine mind into channels of research—a mind peculiarly adapted to that kind of endeavor. Mme. Curie's visit has accomplished more in that direction than would a thousand lectures by men of science."

Mrs. Vernon Kellogg, who was in charge of Mme. Curie's activities in Washington, believes that Mme. Curie's visit has brought home to American women the fact that there is a wider field in which they may serve humanity and add to the achievements of civilzation. Heretofore, Mrs. Kellogg asserted, research work has been regarded as man's sphere. The visit of Mme. Curie, she believes, will stimulate the desire among women to do scientific work.

The program in Washington was carried through without change. The gathering at the White House when the President presented Mme. Curie with the gram of radium was a notable one. The same may be said for the reception held at the Smithsonian Institution. The assemblage at the Interior Department building, when Mme. Curie dedicated the new cryogenic laboratory of the Bureau of Mines, was limited practically to scientists. On this latter occasion Mme. Curie was presented with a representative specimen of the carnotite ore from which her gram of radium was extracted. She also was given a jar of ore taken from the first shipment of the Colorado ore made in 1898.

National Fertilizer Association to Meet at White Sulphur Springs

The twenty-eighth annual convention of the National Fertilizer Association, which will be held at the Greenbrier Hotel, White Sulphur Springs, W. Va., the week beginning June 20, will have a program of reconstruction and cooperation.

The importance of the coming convention cannot be overemphasized. The industry has many problems confronting it, which for proper solution must be given serious and immediate consideration.

The program will include addresses and discussions that are of vital interest to the fertilizer manufacturer in view of present business conditions. These subjects will include: more accurate knowledge of costs; chemical and manufacturing problems; better and cheaper methods of sale and distribution; relations of the industry with county, state and federal educators; transportation and freight problems, etc.

The officers of the association are now arranging the details, and promise a meeting that will be of unusual interest and lasting benefit to everyone identified with the fertilizer industry.

The important meetings will be as follows:

Monday, June 20—Soil Improvement Committee (N.F.A.) Subscribers.

Tuesday, June 21—Southern Fertilizer Association.

Wednesday, June 22—National Fertilizer Association—First Session.

Thursday, June 23—National Fertilizer Association—Second Session.

Etching Reagents for Nickel and Nickel Alloys

An interesting development in connection with the etching of nickel and its alloys is the use of concentrated hydrochloric acid. This appears to be the best reagent for producing contrast without pitting of the surface that has yet been tried. It is rather hard to etch nickel and ordinarily the metal pits considerably and a plain etched pattern—that is, one in which there is no contrast between different grains—is the usual result. Etching in concentrated hydrochloric acid for a considerable period, say one hour or more, gives very satisfactory results.

Chicago Chemists Club Hikes Over Dunes

Hiking over the dune district of Indiana at the southern point of Lake Michigan has been a popular pastime with several Chicago scientific men for many years. Never before, however, has such a large party of chemists enjoyed the pleasures of the dune trails as did the official hikers of the Chicago Chemists Club on Sunday, May 15. Arranged by P. N. Leech and guided by the dune authority, Dr. A. J. Cramp, seconded by Mrs. Cramp, about seventy members trailed from Tamarack to Tremont, stopping at one of the large sand blowouts for lunch. The ladies took the short trail, the men the long trail.

From barren wastes to tropical vegetation, from cactus to tamarack, from orchids to pine trees and the cold wind of the lake to the oppressive heat of the swamps the party explored the wonders of the remarkable region. Like the marvels of the Grand Canyon of Arizona, the dunes of Indiana must be visited to be appreciated. The chemists of Chicago were thoroughly initiated to the aggregation of dune boosters. An impromptu baseball game while waiting for the train at Tremont closed a perfect day.

Goodyear Tire & Rubber Co. Reorganization

Edward G. Wilmer, formerly vice-president of the Steel & Tube Co. of America, is the new president of the Goodyear Tire & Rubber Co. His election to that office was announced following a meeting at which the reorganization of the company was completed. He succeeds F. A. Seiberling, whose resignation was part of the program of the new interests identified with the company.

The new board of directors was announced as follows: J. P. Cotton, of McAdoo, Cotton & Franklin; P. W. Litchfield, of Akron; Grayson M. P. Murphy, of New York City; J. R. Nutt, president of the Union Trust Co. of Cleveland; Robert C. Schaffner, of A. G. Becker & Co., Chicago; A. A. Schlesinger, president of the Steel & Tube Co. of America; G. M. Stadelman, of Akron; Ralph Van Vechten, vice-president of the Continental & Commercial Trust & Savings Bank, Chicago, and Mr. Wilmer.

Messrs. Stadelman and Litchfield are to continue with the company as vice-presidents. H. H. Sprinford is treasurer and Charles A. Stillman secretary.

Mr. Wilmer, who is a comparatively young man, will, it was stated, move from Milwaukee to Akron and devote all his time to the affairs of the company. Before becoming associated with the Steel & Tube Co. he was active in the mining industry, being identified with iron ore and coal mining projects.

General Asphalt Co. Annual Meeting

At the annual meeting of the General Asphalt Co., held in Camden, N. J., three directors whose terms expired, Henry W. Biddle, Charles E. Ingersoll and Sidney F. Tyler, were re-elected for terms of three years.

President Arthur W. Sewall told the stockholders that the manufacturing part of the company's business in January and February was only about 20 per cent as large as in the corresponding months of 1920 and in March and April about 33 per cent. So far in May, however, there are indications of some further recovery.

Since the fire at the Maurer, N. J., plant the manufacture of products such as roofings, floorings, etc., has been carried on at the Madison, Ill., plants. Operations at Maurer have been confined to oil refining and the preparation of asphalt. Officials expect to resume manufacturing at Maurer in June.

May Continue Dye Licensing

The statement was made on the floor of the Senate May 23 that the Committee on Ways and Means of the House will recommend that the licensing and embargo provisions contained in the emergency tariff bill be continued for a period of five years. Senator King, in a speech on the floor of the Senate, characterized such legislation as un-American and indefensible on any economic grounds. He declared that it would perpetuate a dye monopoly in the United States.

Corn Products Refining Co. Operating at Slightly Over 50 Per Cent

The Corn Products Refining Co. is now operating something over 50 per cent of capacity, grinding 75,000 to 80,000 bushels of corn a day. Its capacity is about 155,000 bushels a day. As in other lines of business, the company's volume has decreased because of the hand-to-mouth buying policy of the consumer, according to E. T. Bedford, chairman of the board. On the other hand, Mr. Bedford points out that the corn products manufactured by the company are staple food commodities, whose consumption is not subject to wide fluctuations. He expects some increase in business as the year progresses. Inventories are known to be low, and there are no large accumulated stocks which must be worked off.

The company's English plant finds it impossible to get coal, because of the coal strike. The two small German plants are running full and doing a good business. The French plants are now in course of construction. They should be running full by the late summer. Their capacity is 10,000 bushels of corn a day. Demand which these plants will later fill is being cared for by shipments from United States. The extent of foreign business will be governed entirely by the course of the foreign exchanges, any improvement being reflected in better export business.

An idea of the enormous volume of business transacted by the company may be gained from the fact that it sold 400,000,000 separate packages of products last year. The company is an enormous user of tinplate for containers.

Electrochemists to Meet at Lake Placid

The directors of the American Electrochemical Society have decided to hold the fall meeting at Lake Placid, N. Y., Sept. 29 and 30, and Oct. 1. Arrangements have been made to keep Lakeside Club house open for this occasion. Special effort is being made to provide an interesting technical program, including special symposia on non-ferrous electrometallurgy and on electrodeposition, the latter including electroplating, electrotyping and electrolytic refining. The organization of a division on electrodeposition is in prospect.

Members of the society are urged to consider the feasibility of combining a vacation outing with the convention, spending some time at Lake Placid either before or after the dates of the meeting. Full details as to transportation, accommodations, rates, etc., will be mailed to members of the society and published later in this magazine.

Coloring Gem Stones With Radium Emanation

Experiments which hold the promise of giving color to colorless gem stones through exposure to radium emanation are being carried on at the Rare and Precious Metals Station of the United States Bureau of Mines at Reno, Nev. In preliminary experiments, a colorless Colorado topaz was tinted yellow by exposure to penetrating radiation. The coloring, however, was found not to be permanent when exposed to light. Experimental work with a view to making the color light permanent is being continued.

If these later experiments should prove successful and it is found that radium possesses the power to color gem stones, the discovery would increase the commercial value of gem stone material found largely in the West, the market value of which has been lessened on account of the lack of tint deemed essential by gem fanciers.

Phosphate Export Association

The Phosphate Export Association, comprising four member concerns in New York City (International Agricultural Corporation, Coronet Phosphate Co., the Phosphate Mining Co. and Southern Phosphate Corporation) have combined, for the purpose of export trade, with the Florida Hard Rock Phosphate Export Association, comprising five member concerns in Florida and Georgia (J. Buttgenbach & Co. of Dunnellon, Fla.; C. & J. Camp of Ocala, Fla.; Gummer Lumber Co., of Jacksonville, Fla.; Dunnellon Phosphate Co., of Savannah, Ga.; and Mutual Mining Co., of Savannah). Papers have been filed with the Federal Trade Commission under the export trade act (Webb-Pomerene law). The main office of the combination will be located in New York City, with branches in Savannah, Ga., and London, England.

Phosphate rock is used principally as a fertilizer, either directly, with no further treatment than grinding, or changed to acid phosphate by chemical treatment.

A market for Florida land pebble phosphate and Florida hard rock phosphate has already been established in the United Kingdom, Continental Europe and Japan.

Phosphate exports from the United States in 1920 amounted to 344,896 tons of hard rock, shipped from the ports of Fernandina and Jacksonville, Fla., and 693,355 tons of land pebble, shipped from Tampa, Port Tampa and Boca Grande, Fla.

New Tanning Material

Experiments conducted in recent months at the Laboratoire General des Productions Coloniales, Paris, France, show the value as a tanning material of a plant known as *Acacia arabica*. Investigations indicate that it can be used for tanning either alone or with sumac, quebracho and oak bark. It is said that there is a possibility of the material later replacing Sicilian sumac.

Personal

Dr. CARL L. ALSBERG, chief of the Bureau of Chemistry, Washington, D. C., was elected an honorary member of the American Oil Chemists' Society in session in Chicago May 17.

HAL T. BEANS and THOMAS B. FREAS, who were associate professors of chemistry at Columbia University, and MARIE REIMER, associate professor at Barnard College, have been given the rank of full professors. SAMUEL J. KIEHL, instructor in chemistry, and E. G. MILLER, Jr., associate in biological chemistry, have been made assistant professors. This announcement by the trustees of Columbia University follows closely upon the statement that the chemistry building is to be one of the two buildings erected on the Morningside campus in the immediate future. It serves also to emphasize the statement recently made by Dr. Nicholas Murray Butler, president of the university, that "the central science just now and the one that is likely to remain the central science for some time to come, is that many-sided body of knowledge called chemistry."

H. M. COOPER has been placed in charge of all analytical coal work of the Bureau of Mines, Pittsburgh, Pa.

R. ADAMS DUTCHER, a graduate of South Dakota State College, has resigned his position in the agricultural biochemistry department of the University of Minnesota to accept the position of chief of the agricultural chemistry department of the Pennsylvania College of Agriculture.

Prof. TREAT B. JOHNSTON of Yale University delivered a special lecture on biochemistry before the Philadelphia Section of the American Chemical Society in Philadelphia on the morning of May 19.

N. D. LAMBERT, formerly assistant superintendent in the New York Mutual Gas Light Co., has joined the Lambert Meter Co. as its chief engineer, secretary and treasurer.

EDWIN E. SLOSSON of the National Research Council was in Chicago recently and delivered a lecture at the University of Chicago.

BRADLEY STOUGHTON, secretary of the American Institute of Mining and Metallurgical Engineers since 1913, has tendered his resignation to be accepted at the convenience of the board of directors.

At the May meeting of the Chicago Chapter of the American Society for Steel Treating, held Monday, May 16, 1921, the following officers were elected for the ensuing year: Chairman, H. F. Wood, metallurgist, Ingalls Shepard Division, Wyman Gordon Co., Harvey, Ill.; vice-chairman, P. A. Lovegren, Standard Forgings Co., Indiana Harbor, Ind.; secretary-treasurer, Harry Blumberg, metallographist, Illinois Steel Co., Chicago, Ill.

Current Market Reports

The Chemical and Allied Industrial Markets

NEW YORK, May 28, 1921.

New indications of improvement have been noted in the chemical market during the past week. Conditions, however, still remain quite unsettled, but it is apparent that the pendulum is once more swinging in the right direction and it looks as though a slow but steady improvement in the volume of business may be expected.

There were domestic inquiries for numerous quantities of solid *caustic soda* and these had a strengthening influence on prices in the late trading. Since caustic is considered the actual guide for all of the more important chemicals, it is certain that the rest of the list will follow along the same steady lines. Caustic soda has advanced from $3.60 per 100 lb. to $3.85. It is very doubtful if the inquiry could be filled at any lower figure. The textile, soap, oil and other large consuming industries came into the market in better buying spirit than at any other time since last November. Soapmakers around New York purchased tremendous quantities of tallow and oil. Along with caustic soda there has been a heavy demand for *soda ash*, with a decidedly strong market for spot material. Small lot inquiries for *bichromate of soda* kept prices steady at 8@8¼c. per lb. *Nitrite of soda* was pushed to 8c. per lb. under better selling early in the week, but lost a little of its firmness and closed at 7½c. *Citric acid* recovered somewhat from its recent slump and displayed a slight spurt that may last during the hot weather. Resale *caustic potash* developed a little firmer tendency and reports were current that soapmakers had purchased several large quantities around the extremely low figures. *Bleaching powder* has moved quite freely to paper mills and bleacheries. The general price has been 2¼c. per lb. f.o.b. works, although it is rumored that this figure has been shaded where round lot business was at hand. There was some buying noted on *oxalic acid* for laundry supply houses and textile mills have kept domestic material in a somewhat steady position. The imported variety was held at 16¾c. per lb. and upward according to seller and quantity. *Copper sulphate* has shown improved buying from textile mills and agricultural interests, and business, although not up to the standards of the previous year, is gradually coming into proportion to a seasonable average. The general tone was quite steady.

EXPORT CONDITIONS

The export trade is coming along rather slowly. There are some makers who say they are getting better inquiries from South America and that the Orient is just trying the market out with small miscellaneous inquiries, but as far as actual placing of large business is concerned there is not very much to state and the outlook is very uncertain until ways and means are found to extend foreign credits. Most foreign buyers are demanding three to six months' time for payment and this is the fundamental drawback that is keeping American interests away from active competition for the export trade. Soda ash is still attracting most attention for import. June shipments of English ash are offered at $1.90 N. Y. Oxalic acid is not far below domestic prices when the 1½c. per lb. duty is allowed. The inside German price is said to be 14c. per lb. at German producing points.

It may be stated generally that the tendency of trade is toward expansion. Manufacturers, dealers and jobbers have reduced their surplus stocks in most quarters and there is not as much pressure on prices now as was noted formerly from accumulations. The same condition is practically true in the consuming trade and these two factors combined seem to forecast an early revival of sound business. The placing of large foreign loans and the eventual establishment of foreign credits appear to be reasonably near. A revival in our export trade would add considerably to our domestic business.

Dealers offered spot *carbonate of potash*, 80-85 per cent, calcined, at 6c. per lb. and stated that sales are going through at this figure in a small way. The movement at present is rather quiet and it is possible that a slight concession might be made on a firm order. Resale spot *bichromate of soda*, standard make, is holding firm at the late advance and dealers report a fair inquiry for moderate quantities. Prices range from 8@8½c. per lb., according to quantity and seller. Limited resale offerings of solid *caustic soda* are keeping the spot market in a firm position and the best price heard at the closing was $3.85 per 100 lb. Dealers quoted the market at $3.85@$3.90 per 100 lb., ex-store, and at 4c. per lb., f.a.s. steamer N. Y. The inquiry was rather active, although buyers are showing some hesitation in committing themselves owing to the advanced prices named. First hands quote the market for *chlorate of soda* firm at former prices and report a fair inquiry from the domestic consuming trade. Standard American goods are obtainable at 7½c. per lb. f.o.b. works, for prompt shipment. There were a number of sales of *nitrite of soda* on spot reported at 7½c. per lb. The feeling in this commodity continues firm, with sellers asking up to 8c. per lb. Several interests continue to predict higher prices and are not recognizing the present level with their offerings. Several sellers of imported *prussiate of soda* have advanced the market to 13c. per lb. ex-store N. Y. Other dealers state that 12½@12¾c. can still be done, although they admit that the holdings are becoming smaller and there is a tendency to tighten up offerings in most directions. Light *soda ash* for resale in single bags is held at $2.15 per 100 lb. Less than carload lots in barrels are moving at $2.50@$2.60 per 100 lb. and it is said to be doubtful if much below the inside price could be done on carload lots on account of the limited extent of resale stocks. Small sales of lump *potash alum* are reported at 4c. per lb. Producers named the same price for *ammonia alum* with the usual advance for ground and powdered. The general movement is quiet with small lot sales attracting the most attention. Odd lots of resale *formaldehyde* were offered at 14c. per lb. f.o.b. works. The spot market for prime material appears quite steady at 14½@15c. per lb.

The market on *ethyl alcohol* is reported as easy, while the movement into consuming channels is of a light routine nature with prices quoted at $4.75@$4.95 per gal. Competition in *denatured alcohol* is still keen owing to easy supplies and light demand, and prices range from 31@42c. per gallon, depending on formula. Trading in *methanol* holds to light routine lines, with the 95 per cent quoted at 75@77c. per gal. and the 97 per cent at 78@82c. per gal. The market on *shellac* is holding firm and with the prospects of very little in the way of shipments expected the tendency of prices will be upward for a while. The T.N. is in good demand for bleaching purposes and limited supplies are keeping prices on the jump, with the market quoted at 70@72c. per lb.

COAL-TAR PRODUCTS

The tone of the coal-tar products market became more steady with the encouraging news that the emergency tariff bill, having to do with the dye measure to extend protection for three months against dumping, has been passed by both houses and is awaiting the signature of the President. There is a pronounced feeling of security among the leading producers and increased activity was noted throughout the list, whereas a few weeks ago curtailment was the rule. The crude market is steady and some products are becoming more active. *Benzene* is in good demand and supplies are none too plentiful, while prices remain firm at 27@30c. per gal. for the pure grade and 25@28c. for the 90 per cent. *Naphthalene* is easy, with the flakes quoted at 7½@8c. per lb. and the balls at 8½@9½c. *Phenol* is rather quiet, with supplies ranging from 10@14c. per lb.

The demand for intermediates is confined to limited quantities, but this demand seems to be slowly broadening out, reaching among some of the more inactive producers. *Aniline oil* is quiet and prices range from 20@25c. per lb., depending on seller and quantity. Sellers of *beta naphthol* are steady in their views and prices range from 34@45c.

per lb. There is little activity in *dimethylaniline* and prices are quoted at 41@50c. per lb. Consumers of *diphenylamine* show some interest here and there and prices range from 60@70c. per lb. *Paranitraniline* is reported steady at 85c.@$1 per lb. Producers report a limited amount of routine business passing in *alpha-naphthalamine*, but little in the way of new demand is noted. Supplies are quoted on the basis of 35@40c. per lb.. depending on quantity. The consuming demand for *benzidine* is quiet and moving in small lots. Supplies are reported in fair volume and while sellers' views are around $1@$1.05 per lb., shading is being done on firm business. The sulphate is quoted at 75@85c. per lb. The market for *cresol* reflects a more active demand and sellers are steady in their ideas on prices at 16@18c. per lb. The market is reported easy on supplies of *cresylic acid*, although of late a slightly better demand has been noted. Prices have shown practically no change from former levels with the 97-99 per cent quoted at 70@80c. per gal. and the 95-97 per cent at 65@70c. per gal. Producers are firmer in their views on *salicylic acid* and quote 26c. per lb. for the U.S.P. grade. The technical is steady at 22@24c. per lb. The production of *ortho-amidophenol* is confined to only a few factors. The demand is of a light routine nature, although a slight increase in the inquiry is noted. Prices are quoted at $3@$3.10 per lb., but a firm order will no doubt bring out lower prices.

Waxes

The market for *beeswax* was practically unchanged, with trading reported as routine only. Crude African held at 16@17c. per lb., with the Brazilian at 24@26c. per lb. Importations of beeswax for the nine months ended with March were officially placed at 1,826,864 lb., which compares with 2,247,286 lb. for the corresponding period one year ago. Traders of *carnauba wax* report a moderate buying interest in futures, but spot inquiries remained quite light. Prices were unsettled, especially on the higher grades. No. 2 North Country closed at 28@30c. per lb., with the No. 3 North Country at 16@17c. per lb. There were sellers of *Japan wax* on the spot market at prices ranging from 18@18½c. per lb., depending on quantity and seller. The market was barely steady in some quarters, while others stated that inquiries were being received in moderate volume. At any rate, trading was quiet and with futures available at concessions the situation seemed to favor buyers. The export inquiry on *paraffine wax* was quiet and with trading in a domestic way also inactive prices were irregular with some traders showing a willingness to shade prices. Exports of paraffine in March amounted to 14,173,706 lb., which compares with 45,753,998 lb. for March, 1920. Exports for the nine months ended with March amounted to 213,617,355 lb., contrasted with 256,905,209 lb. for the corresponding period one year ago. Scale wax, 122-124 deg. melting point, closed nominally at 2½@2¾c. per lb. Refined wax, 128-130 deg. melting point, settled around 5c. per lb.

The St. Louis Market

St. Louis, May 27, 1921.

Business during the past two weeks has assumed a brighter aspect. While individual orders remain small, the demand for chemicals has improved and is one of wider scope. The general tone of the market is optimistic. Business in all groups has been considerably better than in the immediate past and sellers are encouraged over the outlook for the future.

Alkalis

The market on *caustic soda* is dull with inquiry much below routine, but a little activity in price. *Soda ash* continues to enjoy routine demand, with business confined principally to jobbing lots at $3 per 100 lb. in barrels, basis 58 per cent. Heavy stocks of *bicarbonate of soda* are being liquidated on basis of the new manufacturing schedule plus freight.

Industrial Chemicals

Sulphur continued to remain very firm at 2½c. per lb., with usual good demand. There has been no change in *ammonia water*, 26 deg., and sales during the past two weeks have shown a slight increase. *Sodium hyposulphite* is moving in the routine way. A heavy demand for *zinc stearate* has been evidenced in the past several weeks and with the approach of summer a large volume of business should be expected, hence suppliers should endeavor to keep maximum stocks. The *zinc* market is stiffening and *sulphate* is being quoted 3¼@3½c. lb. f.o.b. producers' works.

Drugs and Pharmaceuticals

Bismuth preparations continue to be very active. *Cream of tartar* is in fair demand. Very good business has been passing on *iodides*, with a firm market. The demand for *sodium benzoate* is increasing, and prospects for the future are encouraging in view of the preserving and canning season. There has been a decline of 2c. per lb. on *sodium bromide* and 5c. per lb. on *potassium bromide*, which probably has been forced by the low offerings of the foreign producers. *Hard mercurials* have declined recently. The prices of *zinc oxides* remain the same, but the demand for the 5 and 10 per cent leaded by the paint trade has increased sales on these particular grades, while the lead free continues to command a good demand. *Glycerine* was unable to hold its recent advance to 17c. and has dropped back to its low level of 16½c.

Acids

Citric acid has not shown the improvement which was expected; in fact, the demand has been very quiet, with no change in price; however, there are distressed lots being offered at considerably below the ruling market figure. *Tartaric acid* has been commanding good demand, with a firm market.

Coal-Tar Products

The supply of *benzene* is rather limited, due to a curtailment in production, and the demand is fairly good.

Vegetable Oils

Linseed oil has continued its steady advance in the past two weeks and today holds firm at 77c., basis raw, from warehouse in cooperage. The usual differential for direct shipments in carlots prevails and some crushers are booking at the above price to Aug. 1. After a rise to 83c. maximum, *turpentine* slowly declined and today is holding at 69c. with fair demand. *Castor oil* has advanced and today holds at 10½c. in drums or 11c. in barrels.

The Iron and Steel Market

Pittsburgh, May 27, 1921.

Production of steel has shown a distinct declining tendency in the past week. At no time this year has there been any material increase in the rate. While the present decline is not rapid, it is impressive for two reasons, because it is from an already low rate, say 30 per cent of capacity, and because it is shared alike by the Steel Corporation and the independents. During the first three months of the year the Steel Corporation's rate, which had been above 90 per cent, declined almost continuously and rather sharply, but the independents were operating at a shade better rate at the beginning of April than at the beginning of January. Now the corporation is operating at about 35 per cent or a trifle more and the independents at between 20 and 25 per cent.

All producers are filling orders and specifications, as received, as promptly as possible, and some remarkable records are made. There is scarcely any tonnage at all that is scheduled ahead, and often, indeed usually, when a mill or department starts a week at a certain percentage rate it is not known at what rate it will be working on Friday or Saturday. Thus the producers have no reserve and production promptly follows the rate at which orders and specifications are received.

Buyers are in a corresponding position. They do not order material ahead, but hold back their commitments until the last moment, usually making up an order or specification for a single carload, containing a wide variety of sections or descriptions of material. The matter that is often prom-

inent in a market not overly strong, price guarantee to date of shipment, does not arise, for there is scarcely any interval between the placing of the order and the actual shipment.

Prices Hold

The equalized prices developed about the middle of April are holding very well, sales at concessions being very rare in point of numbers, but that condition may be attributed to the character of the business being done rather than to the steel market having any inherent strength. Orders are so small that it is hardly worth while to seek a cut price, and there is usually not sufficient time. Again, the producer has no incentive to cut prices, since there is not enough business offered to give any promise that operations could be swelled by the price-cutting route. In occasional instances an order of exceptional size may go at a concession, but it should be remembered that in the past such concessions have been given in a market that was distinctly strong.

There is no expectation whatever on the part of either sellers or buyers that the present steel prices will hold through another buying movement, one of anything like ordinary proportions. It is generally accepted that the present market prices are simply for present conditions and that when any latent buying disposition develops the sellers will meet the buyers half way or more than half way. With a larger operation production costs would be materially reduced. They are very high now, even without inclusion of overhead.

Wages

A large steel interest east of Pittsburgh has reduced its rate for common labor to 30c. an hour, while no overtime for hours in excess of eight in the day is allowed. Other mills have shown no disposition to adopt a 30c. rate, though it is a common opinion that by the time the present general readjustment in industrial and economic conditions is completed the common labor rate is likely to be about 30c. The steel industry considers the cost of living very high and expects a further and substantial decline. A few mills have eliminated overtime payments, but the more common practice at mills and furnaces in the north is to pay 33c. or 37c. for common labor, with time and a half for the hours in excess of eight. In 1913 the prevailing rate was 19c., without overtime, while in 1898 the common rate was 13c.

Prospects

The demand for steel having shown no tendency to revive, it is considered probable that as July, always a dull month, is approached the demand will grow lighter still, an operation averaging less than 25 per cent of capacity for the steel industry as a whole being in prospect. From such a low rate of operation a rebound seems unavoidable, and improvement is very commonly predicted for August, though from the present outlook anything like full operation is not expected before next spring. The steel industry's capacity being very large, practically unanimous consent of all fundamental conditions is requisite to full employment. All lines of steel consumption must be active, and to be active they must have sound economic conditions. In other words, the cost of consuming steel must be greatly reduced, both the labor cost of the consuming or fabricating operations and the cost of the materials other than steel that are used in conjunction with steel.

Pig Iron

Quotations remain at $24 for bessemer, $22 for basic and $23.50 for foundry, f.o.b. valley furnaces, freight to Pittsburgh being $1.96. Sales have been few and in very small lots. On competitive business for a few hundred tons the foundry iron quotation would probably be shaded.

Coke

Connellsville coke remains quotable at $3.25@$3.50 for furnace and at $5@$5.50 for foundry per net ton at ovens. Some particularly good grades for furnace coke have brought $3.75, for purposes other than iron making, and it is reported that coke for making low-phosphorus iron has sold at $3.75, on a contract for several months.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	..... –	$0.40 – $0.45
Acetone	lb.	$0.12½ – $0.12¾	.13 – .13½
Acid, acetic, 28 per cent	100 lbs.	2.50 – 2.75	3.00 – 3.25
Acetic, 56 per cent	100 lbs.	4.00 – 4.25	4.50 – 5.50
Acetic, glacial, 99½ per cent, carboys,	100 lbs.	9.75 – 10.00	10.25 – 10.50
Boric, crystals	lb.	.13½ – .14	.14½ – .15
Boric, powder	lb.	.15 – .15½	.16 – .16½
Citric	lb.	..... –	.45 – .46
Hydrochloric	100 lb.	1.50 – 1.65	1.75 – 2.00
Hydrofluoric, 52 per cent	lb.	.12½ – .12½	.12½ – .13
Lactic, 44 per cent tech	lb.	.10 – .11	.11½ – .12
Lactic, 22 per cent tech	lb.	.04½ – .05¼	.06 – .07
Molybdic, C. P.	lb.	4.00 – 4.50	4.50 – 5.00
Muriatic, 20 deg. (see hydrochloric)		..... –	..... – .....
Nitric, 40 deg	lb.	.06½ – .06¾	.07 – .07½
Nitric, 42 deg	lb.	.07½ – .07¾	.07½ – .08¼
Oxalic, crystals	lb.	.16½ – .16¾	.17 – .18
Phosphoric, Ortho, 50 per cent solution	lb.	.17 – .17½	.18 – .19
Picric	lb.	.20 – .25	.27 – .35
Pyrogallic, resublimed	lb.	..... –	1.90 – 2.15
Sulphuric, 60 deg., tank cars	ton	..... –	11.00 – 12.00
Sulphuric, 60 deg., drums	ton	..... –	13.00 – 15.00
Sulphuric, 66 deg., tank cars	ton	18.00 – 20.00	..... – .....
Sulphuric, 66 deg., drums	ton	22.00 – 22.50	23.00 – 23.50
Sulphuric, 66 deg., carboys	ton	..... –	..... – .....
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	23.00 – 24.00	..... – .....
Sulphuric, fuming, 20 per cent (oleum) drums	ton	25.00 – 26.00	26.50 – 27.00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	31.00 – 32.00	33.00 – 34.00
Tannic, U. S. P.	lb.	..... –	.90 – 1.00
Tannic (tech.)	lb.	.50 – .52	.54 – .57
Tartaric, crystals	lb.	..... –	.30 – .32
Tungstic, per lb. of WO	lb.	..... –	1.30 – 1.40
Alcohol, Ethyl	gal.	..... –	4.75 – 4.95
Alcohol, Methyl (see methanol)		..... –	..... – .....
Alcohol, denatured, 188 proof	gal.	..... –	.31 – .36
Alcohol, denatured, 190 proof	gal.	..... –	.38 – .42
Alum, ammonia lump	lb.	.04 – .04¼	.04¼ – .04½
Alum, potash lump	lb.	.04 – .04¼	.04¼ – .05
Alum, chrome lump	lb.	.13 – .13½	.14 – .14½
Aluminum sulphate, commercial	lb.	.01½ – .02	.02½ – .02½
Aluminum sulphate, iron free	lb.	.03 – .03½	.03½ – .04
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.07½ – .07¾	.08 – .08¼
Ammonia, anhydrous, cyl. (100-150 lb.)	lb.	.30 – .32	.33 – .35
Ammonium carbonate, powder	lb.	.08 – .08½	.09 – .10
Ammonium chloride, granular (white salamoniac)	lb.	.06¼ – .07	.07¼ – .07¾
Ammonium chloride, granular (gray salammoniac)	lb.	.08 – .08½	.08½ – .09
Ammonium nitrate	lb.	.08 – .08½	.09 – .10
Ammonium sulphate	100 lb.	2.50 – 2.75	2.80 – 2.90
Amylacetate	gal.	..... –	4.00 – 4.25
Amylacetate tech	gal.	..... –	2.50 – 3.00
Arsenic oxide, (white arsenic) powdered	lb.	.07½ – .08	.08½ – .08½
Arsenic, sulphide, powdered (red arsenic)	lb.	.12 – .12½	.13 – .14
Barium chloride	ton	58.00 – 59.00	60.00 – 65.00
Barium dioxide (peroxide)	lb.	.19 – .20	.21 – .22
Barium nitrate	lb.	.08½ – .09	.09½ – .10
Barium sulphate (precip.) (blanc fixe)	lb.	.04½ – .05	.05½ – .06
Bleaching powder (see calc. hypochlorite)		..... –	..... – .....
Blue vitriol (see copper sulphate)		..... –	..... – .....
Borax (see sodium borate)		..... –	..... – .....
Brimstone (see sulphur, roll)		..... –	..... – .....
Bromine	lb.	.41 – .42	.43 – .45
Calcium acetate	100 lbs.	2.00 – 2.05	..... – .....
Calcium carbide	lb.	.05½ – .05¾	.06 – .06½
Calcium chloride, fused, lump	ton	24.00 – 25.00	26.00 – 27.00
Calcium chloride, granulated	lb.	.01½ – .02	.02½ – .02½
Calcium hypochlorite (bleach'g powder)	100 lb.	2.25 – 2.40	2.50 – 2.75
Calcium peroxide	lb.	..... –	1.40 – 1.50
Calcium phosphate, tribasic	lb.	..... –	.15 – .16
Camphor	lb.	..... –	.65 – .67
Carbon bisulphide	lb.	.07 – .07½	.07½ – .08
Carbon tetrachloride, drums	lb.	.10 – .10½	.11 – .12
Carbonyl chloride (phosgene)	lb.	..... –	.75 – 1.00
Caustic potash (see potassium hydroxide)		..... –	..... – .....
Caustic soda (see sodium hydroxide)		..... –	..... – .....
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.08 – .09	.09½ – .10
Chloroform	lb.	..... –	.42 – .44
Cobalt oxide	lb.	..... –	3.00 – 3.10
Copperas (see iron sulphate)		..... –	..... – .....
Copper carbonate, green precipitate	lb.	.20 – .21	.22 – .23
Copper cyanide	lb.	..... –	.50 – .62
Copper sulphate, crystals	lb.	.05½ – .05¾	.06 – .06¼
Cream of tartar (see potassium bitartrate)		..... –	..... – .....
Epsom salt (see magnesium sulphate)		..... –	..... – .....
Ethyl Acetate Com. 85%	gal.	..... –	1.00 – 1.05
Ethyl Acetate pure (acetic ether 98% to 100%)	lb.	..... –	.50 – .52
Formaldehyde, 40 per cent	lb.	.14½ – .14¾	.15 – .15½
Fusel oil, ref.	gal.	..... –	3.00 – 3.25
Fusel oil, crude	gal.	..... –	1.75 – 2.00
Glauber's salt (see sodium sulphate)		..... –	..... – .....
Glycerine, C. P. drums extra	lb.	..... –	.17 – .17½
Iodine, resublimed	lb.	..... –	3.75 – 3.85
Iron oxide, red	lb.	..... –	.10 – .20
Iron sulphate (copperas)	100 lb.	1.00 – 1.25	1.50 – 1.75
Lead acetate,	lb.	..... –	.11½ – .13½
Lead arsenate, paste	lb.	.09 – .09½	.10 – .11
Lead nitrate	lb.	..... –	.15 – .20
Litharge	lb.	.08½ – .09	.09½ – .10
Lithium carbonate	lb.	..... –	1.30 – 1.40
Magnesium carbonate, technical	lb.	.09 – .09½	.10 – .11
Magnesium sulphate, U. S. P.	100 lb.	2.75 – 3.00	..... – .....
Magnesium sulphate, technical	100 lb.	..... –	1.10 – 2.25
Methanol, 95%	gal.	..... –	.75 – .77
Methanol, 97%	gal.	..... –	.78 – .82
Nickel salt, double	lb.	..... –	.14 – .14½
Nickel salt, single	lb.	..... –	.15 – .15½
Phosgene (see carbonyl chloride)		..... –	..... – .....
Phosphorus, red	lb.	.45 – .46	.47 – .50
Phosphorus, yellow	lb.	..... –	.35 – .37
Potassium bichromate	lb.	.11½ – .11¾	.12 – .12½

		Carlots	Less Carlots
Potassium bitartrate (cream of tartar)	lb.	$ .. – $....	$0.31 – $0.32
Potassium bromide, granular	lb.	.. –	.16 – .25
Potassium carbonate, U. S. P.	lb.	.35 – .40	.45 – .50
Potassium carbonate, 80–85%	lb.	.06 – .06¼	.06½ – .07½
Potassium chlorate, crystals	lb.	.08½ – .10	.10½ – .14
Potassium cyanide	lb.	.. –	.26 – .28
Potassium hydroxide (caustic potash)	lb.	.05½ – .05¾	.06 – .08
Potassium muriate	ton	50.00 – 53.00	....
Potassium iodide	lb.	.. –	2.75 – 3.00
Potassium nitrate	lb.	.09½ – .09½	.10 – .12½
Potassium permanganate	lb.	.35 – .36	.37 – .38
Potassium prussiate, red	lb.	.35 – .37	.38 – .40
Potassium prussiate, yellow	lb.	.26 – .26½	.27 – .28
Potassium sulphate (powdered)	per unit	.. –	1.50 – 1.75
Rochelle salts (see sodium potas tartrate)	....	....	.... – ....
Salammoniac (see ammonium chloride)	....	....	.... – ....
Sal soda (see sodium carbonate)	....	....	.... – ....
Salt cake	ton	.... –	32.00 – 33.00
Silver cyanide	oz.	.... –	1.35 – 1.38
Silver nitrate	oz.	.. –	.41 – .42
Soda ash, light	100 lb.	2.15 – 2.20	2.40 – 2.60
Soda ash, dense	100 lb.	2.40 – 2.45	2.50 – 2.75
Sodium acetate	lb.	.04½ – .04¾	.05 – .05½
Sodium bicarbonate	100 lb.	2.25 – 2.40	2.50 – 2.75
Sodium bichromate	lb.	.08 – .08	.08½ – .09
Sodium bisulphate (nitre cake)	ton	5.00 – 5.25	5.50 – 6.50
Sodium bisulphite powdered, U. S. P.	lb.	.05½ – .05½	.05½ – .06
Sodium borate (borax)	lb.	.06½ – .06¾	.07 – .07½
Sodium carbonate (sal soda)	100 lb.	1.90 – 2.00	2.10 – 2.40
Sodium chlorate	lb.	.07½ – .07¾	.08 – .08½
Sodium cyanide	lb.	.22 – .24	.25 – .30
Sodium fluoride	lb.	.12 – .12½	.13 – .14
Sodium hydroxide (caustic soda)	100 lb.	3.85 – 3.90	4.00 – 4.50
Sodium hyposulphite	lb.	.. –	.03½ – .03¾
Sodium nitrite	100 lb.	2.90 –	3.00 – ....
Sodium nitrite	lb.	.07½ – .08	.08½ – .10
Sodium peroxide, powdered	lb.	.25 – .26	.27 – .30
Sodium phosphate, dibasic	lb.	.04½ – .04¾	.05 – .05½
Sodium potassium tartrate (Rochelle salts)	lb.	.. –	.27 – .28
Sodium prussiate, yellow	lb.	.12½ – .13	.13½ – .14
Sodium silicate, solution (40 deg.)	lb.	1.25 – 1.35	1.40 – 1.50
Sodium silicate, solution (60 deg.)	lb.	.02½ – .03	.03¼ – .03¾
Sodium sulphate, crystals (Glauber's salt)	100 lbs.	1.50 – 1.75	2.00 – 2.25
Sodium sulphide, fused, 60-62 per cent cone.	lb.	.05½ – .05¾	.06 – .06½
Sodium sulphite, crystals	lb.	.03½ – .04	.04¼ – .04½
Strontium nitrate, powdered	lb.	.15 – .15	.16 – .17
Sulphur chloride, red	lb.	.07 – .07½	.07½ – .08
Sulphur, crude	ton	20.00 – 22.00	.... – ....
Sulphur dioxide, liquid, cylinders ex	lb.	.08 – .08½	.09 – .10
Sulphur (sublimed), flour	100 lb.	.... –	2.25 – 3.10
Sulphur, roll (brimstone)	100 lb.	.... –	2.00 – 2.75
Tin bichloride, 50 per cent	lb.	.18 – .19	.... – ....
Tin oxide	lb.	.... –	.40 – .42
Zinc carbonate, precipitate	lb.	.16 – .18	.19 – .20
Zinc chloride, gran.	lb.	.11 – .11½	.11½ – .12
Zinc cyanide	lb.	.45 – .49	.50 – .60
Zinc dust	lb.	.12 – .13	.13½ – .14
Zinc oxide, XX	lb.	.08½ – .09	.09½ – .10
Zinc sulphate	lb.	.03¼ – .03½	.04 – .05

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude	lb.	$1.10 — $1.15
Alpha-naphthol, refined	lb.	1.25 — 1.30
Alpha-naphthylamine	lb.	.35 — .40
Aniline oil, drums extra	lb.	.20 — .25
Aniline salts	lb.	.26 — .29
Anthracene, 80% in drums (100 lb.)	lb.	.85 — 1.00
Benzaldehyde U.S.P.	lb.	1.50 — ....
Benzidine, base	lb.	.85 — 1.00
Benzidine sulphate	lb.	.75 — .85
Benzoic acid, U.S.P.	lb.	.65 — .70
Benzoate of soda, U.S.P.	lb.	.65 — .70
Benzene, pure, water-white, in drums (100 gal.)	gal.	.27 — .32
Benzene, 90%, in drums (100 gal.)	gal.	.25 — .28
Benzyl chloride, 95-97%, refined	lb.	.28 — .30
Benzyl chloride, tech.	lb.	.20 — .25
Beta-naphthol benzoate	lb.	3.50 — 4.00
Beta-naphthol, sublimed	lb.	.70 — .75
Beta-naphthol, tech.	lb.	.34 — .45
Beta-naphthylamine, sublimed	lb.	2.00 — 2.25
Cresol, U. S. P., in drums (100 lb.)	lb.	.16 — .18
Ortho-cresol, in drums (100 lb.)	lb.	.25 — .27
Cresylic acid, 97–99%, straw color, in drums	gal.	.70 — .80
Cresylic acid, 95-97%, dark, in drums	gal.	.65 — .70
Cresylic acid, 50%, first quality, drums	gal.	.45 — .50
Dichlorbenzene	lb.	.06 — .09
Diethylaniline	lb.	1.20 — 1.25
Dimethylaniline	lb.	.41 — .50
Dinitrobenzene	lb.	.32 — .35
Dinitroclorbenzene	lb.	.20 — .30
Dinitronaphthalene	lb.	.30 — .40
Dinitrophenol	lb.	.35 — .40
Dinitrotoluene	lb.	.27 — .30
Dip oil, 25%, car lots, in drums	gal.	.40 — .45
Diphenylamine	lb.	.60 — .65
H-acid	lb.	1.30 — 1.50
Meta-phenylenediamine	lb.	1.15 — 1.20
Monochlorbenzene	lb.	.12 — .14
Monoethylaniline	lb.	1.75 — 1.85
Naphthalene crushed, in bbls.	lb.	.07½ — .08½
Naphthalene, flake	lb.	.07½ — .08½
Naphthalene, balls	lb.	.08½ — .09½
Naphthionic acid, crude	lb.	.70 — .75
Nitrobenzene	lb.	.12 — .15
Nitro-naphthalene	lb.	.30 — .35
Nitro-toluene	lb.	.16 — .18
Ortho-amidophenol	lb.	3.10 — 3.20
Ortho-dichlor-benzene	lb.	.15 — .20
Ortho-nitro-phenol	lb.	.80 — .85
Ortho-nitro-toluene	lb.	.15 — .20
Ortho-toluidine	lb.	.20 — .25
Para-amidophenol, base	lb.	1.50 — 1.60
Para-amidophenol, HCl	lb.	1.75 — 1.80
Para-dichlorbenzene	lb.	.15 — .20
Paranitroaniline	lb.	.85 — 1.00
Para-nitrotoluene	lb.	.90 — 1.00
Para-phenylenediamine	lb.	1.85 — 2.00
Para-toluidine	lb.	1.25 — 1.40
Phthalic anhydride	lb.	.50 — .60
Phenol, U. S. P., drums	lb.	.10 — .14
Pyridine	gal.	2.00 — 3.50
Resorcinol, technical	lb.	1.75 — 1.85
Resorcinol, pure	lb.	2.25 — 2.30
Salicylic acid, tech., in bbls.	lb.	.22 — .24
Salicylic acid, U. S. P.	lb.	.26 — .28
Salol	lb.	.85 — .95
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.25 — .28
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.14 — .16
Sulphanilic acid, crude	lb.	.30 — .35
Tolidine	lb.	1.25 — 1.35
Toluidine, mixed	lb.	.40 — .45
Toluene, in tank cars	gal.	.25 — .28
Toluene, in drums	gal.	.28 — .31
Xylidines, drums, 100 gal.	lb.	.40 — .45
Xylene, pure, in drums	gal.	.40 — .45
Xylene, pure, in tank cars	gal.	.45 — ....
Xylene, commercial, in drums, 100 gal.	gal.	.33 — .35
Xylene, commercial, in tank cars	gal.	.30 — ....

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark	lb.	$0.24 — $0.25
Beeswax, refined, light	lb.	.28 — .30
Beeswax, white pure	lb.	.45 — .47
Carnauba, Fl ra	lb.	.60 — .61
Carnauba, No. 2, North Country	lb.	.28 — .30
Carnauba, No. 3, North Country	lb.	.16 — .17
Japan	lb.	.18 — .18½
Montan, crude	lb.	.07 — .07½
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.03½ — .03½
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.02½ — ....
Paraffine waxes, refined, 118-120 m.p.	lb.	.03½ — .03½
Paraffine waxes, refined, 125 m.p.	lb.	.04½ — .04½
Paraffine waxes, refined, 128-130 m.p.	lb.	.04½ — .05
Paraffine waxes, refined, 133-135 m.p.	lb.	.05½ — .05½
Paraffine waxes, refined, 135-137 m.p.	lb.	.05½ — .06
Stearic acid, single pressed	lb.	.09½ — ....
Stearic acid, double pressed	lb.	.10 — ....
Stearic acid, triple pressed	lb.	.11 — .11¼

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl.	280 lb.	$5.10 —	....
Rosin E-I	280 lb.	5.80 —	6.00
Rosin K-N	280 lb.	6.50 —	6.70
Rosin W. G.-W. W.	280 lb.	6.80 —	....
Wood rosin, bbl.	280 lb.	6.25 —	....
Spirits of turpentine	gal.	.69 —	....
Wood turpentine, steam dist.	gal.	.67 —	....
Wood turpentine, dest. dist.	gal.	.65 —	....
Pine tar pitch, bbl.	200 lb.	.... —	6.75
Tar, kiln burned, bbl. (500 lb.)	bbl.	.... —	12.00
Retort tar, bbl.	500 lb.	—	12.00
Rosin oil, first run	gal.	.36 —	....
Rosin oil, second run	gal.	.38 —	....
Rosin oil, third run	gal.	.43 —	....
Pine oil, steam dist., sp.gr., 0.930-0.940	gal.		$1.80
Pine oil, pure, dest. dist.	gal.		1.50
Pine tar oil, ref., sp.gr. 1.025-1.035	gal.		.46
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.		.35
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.		.75
Pine tar, ref., thin, sp.gr., 1.080-1.960	gal.		.35
Turpentine, crude, sp. gr., 0.900-0.970	gal.		1.20
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990	gal.		.35
Pinewood creosote, ref.	gal.		.52

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	$0.41
70-72 deg., steel bbls. (85 lb.)	gal.	.39
68-70 deg., steel bbls. (85 lb.)	gal.	.38
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.30

Crude Rubber

Para—Upriver fine	lb.	$0.16 —	.17
Upriver coarse	lb.	.09 —	.09½
Upriver caucho ball	lb.	.11½ —	.12
Plantation—First latex crepe	lb.	.18 —	....
Ribbed smoked sheets	lb.	.16 —	.16¼
Brown crepe, thin, clean	lb.	.15 —	....
Amber crepe No. 1	lb.	.17 —	....

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	$0.09¼ —	$0.09½
Castor oil, AA, in bbls.	lb.	.10 —	.10¼
China wood oil, in bbls. (f.o.b. Pac. coast)	lb.	.11½ —	.12
Cocoanut oil, Ceylon grade, in bbls.	lb.	.10½ —	.10¾
Cocoanut oil, Cochin grade, in bbls.	lb.	.11¼ —	.11½
Corn oil, crude, in bbls.	lb.	.07½ —	.08
Cottonseed oil, crude (f. o. b. mill)	lb.	.05½ —	.05¾
Cottonseed oil, summer yellow	lb.	.07½ —	.08
Cottonseed oil, winter yellow	lb.	.08 —	....
Linseed oil, raw, car lots (domestic)	gal.	.73 —	.73
Linseed oil, raw, tank cars (domestic)	gal.	.67 —	....
Linseed oil, in 5-bbl lots (domestic)	gal.	.76 —	.76

Olive oil, Denatured	gal.	$1.35 —	$1.50
Palm, Lagos	lb.	.07½ —	.07¼
Palm, Niger	lb.	.05¾ —	.06
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.06 —	.06½
Peanut oil, refined, in bbls	lb.	.10½ —	.10¾
Rapeseed oil, refined in bbls	gal.	.86 —	.88
Rapeseed oil, blown, in bbls	gal.	.92 —	.94
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.07½ —	....
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.05½ —	....
FISH			
Light pressed menhaden	gal.	$0.40 —	$0.41
Yellow bleached menhaden	gal.	.42 —	....
White bleached menhaden	gal.	.44 —	....
Blown menhaden	gal.	.80 —	....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton	$24.00 —	30.00
Barytes, ground, off color, f.o.b. Kings Creek	net ton	22.00 —	26.00
Barytes, crude, 88%@94% ba., Kings Creek	net ton	10.00 —	1 00
Barytes, floated, f.o.b. St. Louis	net ton	26.50 —	28.00
Barytes, crude, first grade, Missouri	net ton	7 00 —	....
Blanc fixe, dry	lb.	.05 —	.05½
Blanc fixe, pulp	net ton	50.00 —	60.00
Casein	lb.	.14 —	.16
Chalk, domestic, extra light	lb.	.05 —	.05½
Chalk, domestic, light	lb.	.04½ —	.05
Chalk, domestic, heavy	lb.	.04 —	.05
Chalk, English, extra light	lb.	.05 —	.07
Chalk, English, light	lb.	.05 —	.06
Chalk, English, dense	lb.	.04½ —	.05
China clay (kaolin) crude, f.o.b. mines, Georgia	net ton	8.00 —	10.00
China clay (kaolin) washed, f.o.b. Georgia	net ton	12.00 —	15.00
China clay (kaolin) powdered, f.o.b. Georgia	net ton	18.00 —	22.00
China clay (kaolin) crude f.o.b. Virginia points	net ton	8.00 —	12.00
China clay (kaolin) ground, f.o.b. Virginia points	net ton	15.00 —	40.00
China clay (kaolin), imported, lump	net ton	23.00 —	25.00
China clay (kaolin), imported, powdered	net ton	30.00 —	35.00
Feldspar, crude, f.o.b. Maryland and North Carolina points	gross ton	8.00 —	14.00
Feldspar, crude, f.o.b. Maine	net ton	7.50 —	10.00
Feldspar, ground, f.o.b. Maine	net ton	21.00 —	23.00
Feldspar, ground, f.o.b. North Carolina	net ton	17.00 —	21.00
Feldspar, ground, f.o.b. N. Y. State	net ton	17.00 —	21.00
Feldspar, ground, f.o.b. Baltimore	net ton	27.00 —	30.00
Fullers earth, f.o.b. Mines	net ton	16.00 —	17.00
Fullers earth, granular, f.o.b. Pa	net ton	15.00 —	18.00
Fullers earth, powdered, f.o.b. Fla	net ton	18.00 —	....
Fullers earth, imported, powdered	net ton	24.00 —	27.00
Graphite, Ceylon lump, first quality	lb.	.07½ —	.08
Graphite, Ceylon chip	lb.	.06 —	.06½
Graphite, high grade amorphous crude	lb.	.02¾ —	.03
Pumice stone, imported, lump	lb.	.04 —	.50
Pumice stone, domestic lump	lb.	.05 —	.05½
Pumice stone, ground	lb.	.06 —	.07
Quartz (acid tower) first to head, f.o.b. Baltimore	net ton	.... —	10.00
Quartz (acid tower) 1¼@2 in., f.o.b. Baltimore	net ton	.... —	14.00
Quartz (acid tower) rice, f.o.b. Baltimore	net ton	.... —	17.00
Quartz, lump, f.o.b. North Carolina	net ton	5.00 —	7.50
Shellac, orange fine	lb.	.75 —	....
Shellac, orange superfine	lb.	.79 —	.82
Shellac, A. C. garnet	lb.	.55 —	.58
Shellac, T. N.	lb.	.70 —	.72
Soapstone	ton	12.00 —	15.00
Sodium chloride	long ton	12.50 —	13.00
Talc, paper-making grades, f.o.b. Vermont	ton	11.00 —	20.00
Talc, roofing grades, f.o.b. Vermont	ton	8.50 —	13.00
Talc, rubber grades, f.o.b. Vermont	ton	11.00 —	18.00
Talc, powdered, Southern, f.o.b. cars	ton	10.00 —	14.00
Talc, imported	ton	35.00 —	40.00
Talc, California talcum powder grade	ton	18.00 —	40.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh	per ton	$35.00 —	50.00
Carborundum refractory brick, 9-in. — less than carlot	1,000	1250.00	
Carborundum refractory brick, 9-in. — carload lots	1,000	1100.00	
Chrome brick, f.o.b. Eastern shipping points	net ton	75 —	90
Chrome cement, 40–45% Cr_2O_3	net ton	45 —	50
Chrome cement, 40–45% Cr_2O_3, sacks, in car lots, f.o.b. Eastern shipping points	net ton	....	55
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	40 —	50
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	40 —	50
Magnesite brick, 9-in. straight	net ton		90
Magnesite brick, 9-in. arches, wedges and keys	net ton		100
Magnesite brick, soaps and splits	net ton		110
Silica brick, 9-in. sizes, f.o.b. Chicago district	1,000	45 —	55
Silica brick, 9-in. sizes, f.o.b. Birmingham district	1,000	45 —	55
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa	1,000	45 —	55

Ferro-Alloys

All f.o.b. Works

Ferro-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	$200.00 —	$225.00
Ferrochrome per lb. of Cr. contained, 6–8% carbon, carlots	lb.	.15 —	.16
Ferrochrome, per lb. of Cr. contained, 4-6% carbon, carlots	lb.	.16 —	.17
Ferromanganese, 76-80% Mn, domestic	gross ton	80.00 —	85.00
Ferromanganese, 76-80% Mn, English	gross ton	80.00 —	85.00
Spiegeleisen, 18-22% Mn	gross ton	30.00 —	32.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo	lb	2.50 —	....
Ferrosilicon, 10-15%	gross ton	50.00 —	55.00
Ferrosilicon, 50%	gross ton	80.00 —	85.00
Ferrosilicon, 75%	gross ton	145.00 —	150.00
Ferrotungsten, 70-80%, per lb. of contained W	lb.	.45 —	.50
Ferrouranium, 35-50% of U, per lb. of U content	lb.	6.00 —	....
Ferrovanadium, 30-40% per lb. of contained V	lb.	5.00 —	6.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content	gross ton	$8.00 —	$10.00
Chrome ore, Calif. concentrates, 50% min. Cr_2O_3	unit	45 —	.50
Chrome ore, 50% Cr_2O_3, f.o.b. Atlantic seaboard	unit	45 —	.50
Coke, foundry, f.o.b. ovens	net ton	4 50 —	5 00
Coke, furnace, f.o.b. ovens	net ton	3 25 —	3.75
Coke, petroleum, refinery, Atlantic seaboard	net ton	15 00 —	16.00
Fluorspar, lump, f.o.b. mines, New Mexico	net ton	15.00 —	....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	20.00 —	22.50
Ilmenite, 52% TiO_2, per lb. ore	lb.	.01¼ —	.01½
Manganese ore, 50% Mn, c.i.f. Atlantic seaport	unit	25 —	....
Manganese ore, chemical (MnO_2)	gross ton	60.00 —	65.00
Molybdenite, 85% MoS_2, per lb. of MoS_2, N. Y.	lb.	.55 —	.60
Monazite, per unit of ThO_2, c.i.f., Atlantic seaport	unit	30.00 —	....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	.14 —	.14
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport	unit	.14 —	.14
Pyrites, domestic, fines, f.o.b. mines, Ga	unit	.12 —	.13
Rutile, 95% TiO_2 per lb. ore	lb.	.15 —	....
Tungsten, scheelite, 60% WO_3 and over, per unit of WO_3 (nominal)	unit	2.75 —	3.00
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3, N. Y. C.	unit	3.00 —	3.25
Uranium ore (carnotite) per lb. of U_3O_8	lb.	1.50 —	2.50
Uranium oxide, 96% per lb. contained U_3O_8	lb.	2.25 —	2.50
Vanadium pentoxide, 99%	lb.	12.00 —	14.00
Vanadium ore, per lb. of V_2O_5 contained	lb.	1.50 —	....
Zircon, washed, iron free	lb.	.03 —	....

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic	13.25–13.50
Aluminum, 98 to 99 per cent	28.00@28.5
Antimony, wholesale lots, Chinese and Japanese	5½
Nickel, ordinary (ingot)	41.00
Nickel, electrolytic	44.00
Monel metal, spot and blocks	35.00
Monel metal ingots	38.00
Monel metal, sheet bars	40.00
Tin, 5-ton lots, Straits	32.25
Lead, New York, spot	5.00
Lead, E. St. Louis, spot	4.75
Zinc, spot, New York	5.25
Zinc, spot, E. St. Louis	4.75

OTHER METALS

Silver (commercial)	oz.	$0.58
Cadmium	lb.	1.00–1.25
Bismuth (500 lb. lots)	lb.	1.50@1.55
Cobalt	lb.	4.00
Magnesium (f.o.b. Philadelphia)	lb.	1.25
Platinum	oz.	72.00–75.00
Iridium	oz.	250.00@300.00
Palladium	oz.	65.00@70.00
Mercury	75 lb.	46.00–47.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	20.50–20.75
Copper bottoms	28.00–28.25
Copper rods	19.25–20.00
High brass wire	18.25
High brass rods	15.25
Low brass wire	20.25
Low brass rods	20.25
Brazed brass tubing	29.00
Brazed bronze tubing	34.25
Seamless copper tubing	22.00
Seamless high brass tubing	21.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound.

	New York — Current	New York — One Year Ago	Cleveland	Chicago
Copper, heavy and crucible	8.50@9.00	18.50	10.00	10.50
Copper, heavy and wire	8.00@8.25	16.50	9.50	9.50
Copper, light and bottoms	7.00@7.50	14.50	9.00	8.50
Lead, heavy	3.25@3.50	7.25	4.00	4.00
Lead, tea	2.15@2.30	5.25	3.00	3.00
Brass, heavy	4.25@4.50	9.50	7.00	10.00
Brass, light	3.00@3.25	8.00	5.00	5.50
No. 1 yellow brass turnings	4.00@4.25	9.50	5.50	6.00
Zinc	2.00@2.50	5.00	3.00	3.50

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ¼ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses in the cities named:

	New York	Cleveland	Chicago
Structural shapes	$2.50	$3.23	$3.23
Soft steel bars	2.50	3.00	3.13
Soft steel bar shapes	2.50	3.13	3.13
Soft steel bands	2.85	3.83	3.78
Plates, ¼ to 1 in. thick	2.50	3.30	3.23

*Add 15c per 100 lb. for trucking to Jersey City and 10c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

MOBILE—The Gilman Paint & Varnish Co., Chattanooga, Tenn., is planning for the establishment of a local plant to be equipped for a capacity of about 2,000 gal. of material per day. K. Y. Benson is vice-president.

Arkansas

LITTLE ROCK—The Rose City Petroleum Co., 407 Donaghey Bldg., recently organized with a capital of $500,000, has plans under way for the erection of a new oil-refining plant on local site, to have an initial capacity of about 1,000 bbl. per day. A. M. Delcambre is president and E. B. Fowler secretary and treasurer.

PICRON—The Arkansas Refineries Co., Little Rock, recently incorporated with a capital of $50,000, is planning for the erection of a new oil refinery at Picron, with initial daily capacity of about 500 bbl. Brooks & Co., Little Rock, will be in charge of erection. Joseph Berger is president.

California

LOS ANGELES—The C. F. Braun Co., San Francisco, manufacturer of metal products, is planning for the removal of its foundries to a site to be selected at Los Angeles. Details of the new plant are being arranged.

PITTSBURG—S. M. Stranahan and J. F. Mora, Pittsburg, are planning for the erection of a new plant at Martinez for the manufacture of a new airless automobile tire and other rubber products. Negotiations are under way with the Board of City Trustees for a suitable site.

Delaware

CLAYMONT—The Wilmington Sugar Refining Co., Wilmington, will resume work at once on its proposed new sugar refinery at Claymont, estimated to cost about $1,000,000 with machinery. The company has a tract of about 11 acres of land, purchased from the Pennsylvania R.R., and a number of buildings will be constructed. The company is capitalized at $30,000,000 and is headed by Adolph Segal, 1710 North 23d St., Philadelphia, Pa.

Georgia

CEDARTOWN—The Brewer Automobile Headlight Co., recently organized, is arranging for the operation of a local plant for the manufacture of automobile headlights and fixtures. I. L. St. Clair is president and general manager.

Indiana

BRAZIL — Officials of the Kalamazoo Tank & Silo Co., operating a local plant for the manufacture of burned clay products, have organized the Kalamazoo Clay Co. The new organization has acquired the property of the Carbon Mining Co., near Brazil, and will establish a works here for the manufacture of burned clay blocks and kindred products. The company is headed by Manvel H. Coombs, James E. Anderson and John S. Rockwell.

ELKHART—The American Coating Mills, manufacturer of enameled paper products, have awarded a contract to Henry L. Vanderhouse, Kalamazoo, Mich., for the erection of the proposed addition to its plant, to be located at the foot of Division St. The new factory with machinery is estimated to cost in excess of $500,000. C. C. Colbert is president and treasurer.

Iowa

DAVENPORT — The Western States Portland Cement Co., Independence, Kan., has construction under way on its new local cement mills, estimated to cost close to $2,000,000 with machinery. A. D. Stancliff is purchasing agent.

Louisiana

MONROE—The Monroe Cotton Oil Co., Newtown, near Monroe, is reported to be planning for the rebuilding of its plant, destroyed by fire May 11 with loss estimated at about $150,000, including equipment.

Maryland

HAGERSTOWN—Fire May 15 destroyed a portion of the mixing plant of the Central Chemical Co., manufacturer of fertilizer products, with loss estimated at about $35,000, including machinery.

Massachusetts

CHESTER—The Cortland Grinding Wheel Co., Cortland, N. Y., has combined operations with the Maxf Grinding Wheel Co., operating a local plant, and the products of both companies will be made in the future at this location. The plant of the Cortland company was destroyed by fire last November, and it is said that it will not be rebuilt at the present time. The officers of both companies will remain as heretofore.

Michigan

THREE RIVERS—The Eddy Paper Co. has arranged for a bond issue of $1,250,000 to be used for general operations, financing, etc. The company's plant has a total capacity of about 100,000 tons of paper per year, with branch works at White Pigeon, Mich.

CHEBOYGAN—The Union Bag & Paper Co. has awarded a contract to J. Livingston & Co., 506 Sloan Bldg., Cleveland, O., for extensions and improvements in its paper mill. A portion of the works will be remodeled. G. S. Witham is general superintendent.

Missouri

PIEDMONT — The Piedmont Units Co. has acquired a tract of land totaling about 6,500 acres, and is planning for the erection of a new plant for the production of charcoal and byproducts. The initial works will comprise a battery of 7 ovens and auxiliary operating equipment. About $100,000 will be expended in the new plant and in property development.

SPRINGFIELD—The Willis-Smiley Producing & Refining Co., Fort Scott, Kan., recently organized, has plans under way for the erection of a new oil refinery in the vicinity of Springfield, to have an initial daily output of about 500 bbl. The plant will be arranged on the unit plan, and the first unit will be added to at a later date. W. E. Willis and W. J. Smiley, both of Fort Scott, head the company.

New Jersey

NEWARK—Aaron Friedman of the New Process Metals Co., 7 Mulberry St., is planning for the erection of a new plant for the manufacture of cerium and other rare earth metallic products.

JERSEY CITY—G. H. Aspinwall, Cornelison Ave., manufacturer of paints, will take bids at once for the erection of a new 2-story plant, 50x60 ft., to cost about $30,000, including equipment. E. M. Patterson, 76 Montgomery St., is architect.

WOODSTOWN—The South Jersey Farmers' Exchange is considering plans for the construction of a new 1-story addition to its fertilizer plant, about 80x200 ft. A. B. Lippincott is manager.

MAURER—The Barber Asphalt Paving Co., Land Title Bldg., Philadelphia, Pa., has awarded a contract for the erection of a new service building at its local plant, 32x52 ft., to J. H. Wester, 221 Brighton Ave., Perth Amboy, N. J.

New York

SYRACUSE—The Thatcher Process Co., organized about a year ago and operating with a capital of $200,000, has commenced production at its new local electrochemical plant for the manufacture of anthraquinone under a special process. The initial output will average about 1,000 lb. per day, and this will be increased at a later date. The company is headed by Carleton A. Chase and James D. Grant.

NEW YORK—The Ruberoid Co., Woolworth Bldg., formerly the Standard Paint Co., has arranged for a bond issue of $1,000,000 for general operations, financing, etc. H. F. Gillespie is vice-president.

ALBANY—The Hires-Turner Glass Co., 30th and Walnut Sts., Philadelphia, Pa., manufacturer of window glass and other rolled glass products, is taking bids for the erection of a new one-story plant on Tivoli St., Albany, to be 150x300 ft., steel and concrete, and estimated to cost about $250,000 with machinery. A. W. Fuller, 95 State St., Albany, is architect.

DUNKIRK—The Thatcher Mfg. Co., 201 West Second St., manufacturer of glass products, is taking bids for the erection of a new 1-story plant to replace a portion of its works recently destroyed by fire.

North Carolina

HENDERSON—The Vance Fertilizer Co. has commenced the erection of a new local plant, to be equipped for the manufacture of commercial fertilizers.

WILMINGTON — The Atlantic Refining Co., 3144 Passyunk Ave., Philadelphia, Pa., is reported to have purchased the Nauli Shipyard, on the Cape Fear River, near Wilmington, and has plans under way for the erection of a large oil refinery on the site.

WILMINGTON—Fire recently destroyed a portion of the plant of the Shepard Chemical Co. No official estimate of loss has been made. Plans are said to be under way for rebuilding. E. C. Dickinson is head.

Ohio

CUYAHOGA FALLS — The Surgeons' Rubber Glove Co., manufacturer of rubber goods, has plans under way for the erection of a new plant. The Akron Engineering Co., Akron, O., is engineer. C. N. Shook, 410 Merline Ave., Cuyahoga Falls, is one of the heads of the company.

CORTLAND—The Quinley Magnesia Co., recently organized with a capital of $100,000, will soon break ground for the erection of a new plant for the manufacture of magnesium and asphalt products. The initial output will aggregate about 4,000 lb. of magnesium carbonate per day. It is proposed to have the first plant unit ready for service during July.

Quebec

EAST ANGUS—The Brompton Pulp & Paper Co. is planning for the rebuilding of the portion of its local mill, destroyed by fire, May 5. The company has arranged for a bond issue of $2,500,000, the proceeds to be used for general operations, expansion, etc. In addition to the East Angus plant, mills are being operated at Bromptonville, Que., Claremont, N. H., and Groveton, N. H., with total annual production of 123,000 tons of newsprint, kraft and fiber paper and groundwood pulp. F. N. McCrea is president.

South Carolina

ALLENDALE—Fire, May 16, destroyed a portion of the plant of the Allendale Cotton Oil & Fertilizer Co., with loss estimated at about $75,000, including equipment and stock.

Tennessee

MEMPHIS—The Memphis Packing Corp., Falls Building, is considering the erection of a new local plant for the manufacture of compounds. The refinery will be operated in conjunction with the present works. Joseph Newburger is president.

MEMPHIS—The Oriental Chemical Co., with offices in the Odd Fellows Bldg., plans the erection of a chemical plant in Hollywood. The officers of this company are W. L. Eichberg, president; W. W. Laughlin, vice-president and W. L. Eichberg, secretary-treasurer.

CHATTANOOGA—The Mutual Enamel Ware Co. is having plans prepared by Dwight P. Robinson & Co., 125 East 46th St., New York City, for the erection of a new local plant for the manufacture of enamel sanitary ware.

Texas

DALLAS—The Southern States Chemical Co., 1831 Clarence St., has plans under way for the erection of a new plant at Houston, comprising four complete units, two of which will be erected at the present time and the others at a later date. The larger unit will be 2 story, brick and steel, totaling about 10,000 sq.ft. of space, and will be equipped for chemical manufacture. The smaller section will be used for byproduct recovery, and will be equipped with distillation apparatus, retorts, etc. The main works will manufacture inks, paints, soaps, etc., in addition to general chemicals. Louis Rosenburg is president.

TYLER—George R. Hill and associates have plans under way for the establishment of a new brick manufacturing plant, to be equipped for a daily output of about 10,000 bricks.

West Virginia

RAVENSWOOD—The Ravenswood Porcelain Co., recently organized with a capital of $500,000, has plans under way for the erection of a new local plant for the manufacture of electrical porcelain products, to be 1-story, 120 x 160 ft. Two kinds will be constructed. The plant is estimated to cost in excess of $30,000 with equipment. Beaty & Halloran, New Haven, W. Va., and Cincinnati, O., are architects. C. E. Mason is president, and C. W. Turnbull, general manager.

Capital Increases, Etc.

THE IMPERIAL DROP FORGE CO., Indianapolis, Ind., has filed notice of increase in capital from $200,000 to $500,000.

THE STAR OIL CO., INC., Port Huron, Mich., has filed notice of increase in capital from $65,000 to $100,000.

THE INDIANA GLASS & FIXTURE CORP., Marion, Ind., has filed notice of change of name to the Therasse Glass Corp.

THE INTER STATE LEATHER CO., 229 West Rand St., Chicago, has filed notice of dissolution under state laws.

F. F. DALLEY CO., 321 Military Rd., Buffalo, N. Y., manufacturer of polishes, has filed notice of increase in capital from $590,000 to $1,340,000.

THE ROGERS RUBBER CO., Westminster, Md., manufacturer of rubber products, has filed notice of reduction in capital from $1,000,000 to $250,000.

THE MARION TIRE & RUBBER CO., Marion, O., manufacturer of rubber products, has filed notice of increase in capital from $750,000 to $1,250,000.

THE MONROE BINDER BOARD CO. and the BOEHME & RAUCH CO., both of Monroe, Mich., manufacturer of paper and fiber board products, have been merged under the name of the Monroe Consolidated Paper Co., with a capital of $7,500,000. E. C. Rauch is president.

New Companies

THE HUNTINGTON SIGNAL OIL CO., Los Angeles, Cal., has been incorporated with a capital of $350,000 to manufacture petroleum products. The incorporators are Carlos C. Closson, 5544 Lexington St., Los Angeles; Frank W. Foster, Artesia, Cal.; and Jewel Irwin, 262 Mira Mar Ave., Long Beach, Cal.

THE FLAGG INK CO., New York City, has been incorporated with a capital of $100,000 to manufacture inks and kindred products. The incorporators are A. B. Flagg, J. Kirschenstein and A. P. Scharps, Tribune Bldg.

THE RORK CHEMICAL CO., 3316 North Halsted St., Chicago, has been incorporated with a capital of $25,000 to manufacture chemical and chemical byproducts. The incorporators are Fred Lackner, M. J. Clark and M. W. Rork.

THE PENNSYLVANIA CHEMICAL CO., Brooklyn, N. Y., has been incorporated with a capital of $25,000 to manufacture chemicals and affiliated products. The incorporators are S. L. Siegler, F. C. Skinner and M. L. Lavey. J. B. Steinfeld, 215 Montague St., represents the company.

THE STANDARD METAL PRODUCTS CO., Boston, Mass., has been incorporated with a capital of $100,000 to manufacture metal specialties. George R. Armstrong is president and Morris M. Fineberg, 34 Orange St., Chelsea, Mass., treasurer.

THE HUNTINGTON ARENA OIL CO., Los Angeles, Cal., has been incorporated with a capital of $500,000 to manufacture petroleum products. The incorporators are J. W. LaFrange and W. A. Davidson, Los Angeles, and James E. Jeter, Glendale, Cal. H. P. Goodwin, 231 Title Insurance Bldg., Los Angeles, represents the company.

JOHN P. CARLSON, INC., Brooklyn, N. Y., has been incorporated with a capital of $100,000 to manufacture printing and lithographic inks. The incorporators are J. P., J. R. and S. Carlson. The company is represented by Durack & Scheilke, 215 Montague St.

THE NITROLOID CO., East Stroudsburg, Pa., has been incorporated with a capital of $50,000 to manufacture pyroxylin and composition products. Julian Davis, Stroudsburg, Pa., is treasurer.

THE HERCULOID PRODUCTS CO., 7 West Madison St., Chicago, has been incorporated with a capital of $75,000 to manufacture wood pulp products and kindred specialties. The incorporators are J. W. Young, A. S. Flett and Benjamin N. Anderson.

THE A. & T. OIL CO., Los Angeles, Cal., has been incorporated with a capital of $750,000 to manufacture petroleum products. The incorporators are T. S. Trebell, Irving V. Augau and Harvey A. Young, 511 Stock Exchange Bldg.

THE NORTHSIDE BRICK CO., Pittsburgh, Pa., has been incorporated with a capital of $50,000 to manufacture brick and other burned clay products. John Schlermann, Millville, Pa., is treasurer.

THE LEBANON GREY IRON CASTINGS CO., Lebanon, Pa., has been incorporated with a capital of $30,000 to manufacture metal castings. The incorporators are Julius H. Caplan and John Hunsicker, Jr., Lebanon.

THE TRIANGLE TANNING CO., Medford, Mass., has been incorporated with a capital of $100,000 to manufacture leather products. Herman See is president; Theodore W. Kerr, 22 Corey St., Medford, is treasurer.

THE MURRAY OIL CO., Room 640, 29 South La Salle St., Chicago, has been incorporated with a capital of 500 shares of stock, no par value, to manufacture oil products. The incorporators are Andrew C. Wylie, Charles Reagh and I. S. Berkman.

THE IMPERIAL PULP & PAPER CORP., New York City, has been incorporated with a capital of $100,000 to manufacture pulp and paper products. The incorporators are W. H. Wilson, J. R. Allen and J. A. Montague. F. J. Knorr, Albany, N. Y., represents the company.

THE HAMILTON TILE CO., Los Angeles, Cal., has been incorporated with a capital of $50,000 to manufacture ceramic tile and other kindred products. The incorporators are M. M. and G. B. Hamilton, and Lawrence W. Allen. Allen, Allen & Swender, Los Angeles, attorneys, represent the company.

THE GROSVENOR PAPER CO., Buffalo, N. Y., has been incorporated with a capital of $100,000 to manufacture paper products. The incorporators are H. A. Grosvenor, E. F. Branch and P. Swift. Swift, Gratwick & Peter Ellicott Sq., Buffalo, represent the company.

THE ATLANTIC & PACIFIC DRUG & CHEMICAL CO., Room 1438, 10 South LaSalle St., Chicago, has been incorporated with a capital of 1,000 shares of stock, no par value, to manufacture chemicals and affiliated products. The incorporators are Hubert E. Howard, John C. Burchard and Herbert Haase.

THE CONSUMERS' BOX CO., Philadelphia, Pa., is being organized by Jesse E. Perry, Ralph L. Patterson and Charles E. White, to manufacture paper boxes and containers. Samuel W. Cooper, Lincoln Bldg., represents the company.

THE LOS ANGELES TIRE & TUBE MFG. CO., 1338 East Slauson Ave., Los Angeles, Cal., has filed notice of organization to manufacture rubber products. T. J. Barker, 1140 East Sixtieth St., heads the company.

THE WENTZELL CHEMICAL DISTRIBUTING CO., New York City, has been incorporated with a capital of $25,000 to manufacture chemical products. The incorporators are E. R. Dick, R. Moulton and E. T. Moriarity. J. P. Nolan, 25 Broad St., represents the company.

THE AIKEN OIL CO., Pittsburgh, Pa., has been organized by F. L. and Clarence Aiken, and I. M. Miller, to manufacture refined oil products. The company is represented by A. L. Petty, Jr., 1156 Frick Annex.

THE IMPERIAL VALLEY CRUDE OIL CO., Los Angeles, Cal., has been incorporated with a capital of $1,000,000 to manufacture petroleum products. The incorporators are J. F. Corbett, C. M. Graham and Frank Muller. The company is represented by Carnahan & Clark, 501 Investment Bldg.

THE OILZUM DISTRIBUTING CO., INC., 4 East Mount Royal Ave., Baltimore, Md., has been incorporated with a capital of $75,000 to manufacture soaps, oils and kindred products. The incorporators are L. Innes Correll, Harold Simester and F. G. Riggs.

THE PERFECT CHEMICAL MFG. & DRUG CORP. has been incorporated with a capital of $50,000 to manufacture chemicals and affiliated products. The incorporators are B. Baum, I. Goldberg and C. Zarem. C. Firstone, 299 B'way, represents the company.

THE CALUMET MALLEABLE IRON CO., 9651 Torrance Ave., Chicago, has been incorporated with a capital of $50,000 to manufacture iron products. The incorporators are Michael J. Boyle, George R. Barker and Thomas E. Duffy.

WENDELL & WARREN, INC., 1601 West North Ave., Baltimore, Md., has been incorporated with a capital of $35,000 to manufacture chemicals, drug compounds, etc. The incorporators are H. George Wendel, Daniel A. Warren and R. E. Lee Williamson.

THE UNITED LABORATORIES, INC., 15 East Washington St., Chicago, has been incorporated with a capital of $100,000 to manufacture chemical and scientific products. The incorporators are C. W. Armstrong, P. C. Hughes and R. M. Hughes.

THE FITZROY CHEMICAL CORP., New York City, has been incorporated with a capital of $25,000 to manufacture chemicals and chemical byproducts. The incorporators are E. L. Mullaney, M. Fitzgerald and F. Persh. The company is represented by Geller & Kraushwaar, 51 Chambers St.

THE ILLINOIS VARNISHED TILE CO., Room 1400, 38 South Dearborn St., Chicago, has been incorporated with a capital of $100,000 to manufacture tile and other ceramic products. The incorporators are Frank P. Page, R. W. Hendershot and James E. Hauronic.

THE MASTER PHONE-DISC CORP., New York City, has been incorporated with a capital of $51,000 to manufacture composition rubber specialties, etc. The incorporators are M. Wiener and W. H. Deuel. S. G. Nissenson, 32 Liberty St., represents the company.

THE BRACKETT-MASON-DODGE CO., INC., Peabody, Mass., has been incorporated with a capital of $50,000 to manufacture cements, finishes and kindred materials for leather tanning. Charles P. Brackett is president and George H. Mason, Saugus, Mass., treasurer.

Industrial Notes

THE THADDEUS DAVIDS INK CO., New York, announces the election of Harold Merckle as president, M. A. Kline as vice-president and treasurer, F. E. Ashley as secretary and T. H. Pancoast as assistant secretary.

B. F. WITBECK has been elected president and treasurer of the Albany Chemical Co., New York. Dr. Michaelis, one of the founders of the company, has been elected chairman of the board of directors. The plant of this company is at Albany, N. Y.

THE QUIGLEY FURNACE SPECIALTIES CO., New York City, announces that W. H. Gaylord, Jr., formerly president of the Gaylord International Engineering Construction Co. and later sales manager of the McPhee Cement Co., has joined the company as assistant traveling sales manager in charge of the establishment of agencies for Quigley products. He will make his headquarters in New York.

THE M. J. DOUGHERTY CO., piping fabricator and contractor of Philadelphia, announces a change of address of its Atlanta, Ga., representative's office to Candler Annex. This office is in charge of Messrs. McKee and Wright. Their territory takes in the states of Florida, Georgia, Alabama, Tennessee, North Carolina and South Carolina.

THE JEFFREY MANUFACTURING CO., Columbus, O., has placed Harold B. Wood in charge of the New York office, which is now located in the Hudson Terminal Bldg., 30 Church St.

C. H. WHEELER MANUFACTURING CO., Philadelphia, announces the opening, June 1, of a branch office in Boston at 53 State St.

THE ESSENKAY PRODUCTS CO., Chicago, manufacturer of art gum, tire filler and allied products, has leased 28,000 sq.ft. of additional floor space at 2601-9 Cottage Grove Ave. Extensive improvements are to be made to transform the building into general office headquarters, salesrooms and factory.

THE AMERICAN ANILINE PRODUCTS, INC., New York City, announces that at the last meeting of the board of directors E. E. Fischer, formerly president and treasurer of the Kalle Color & Chemical Co., Inc., New York, was elected a vice-president and director.

A PERMANENT CONFECTIONERY AND ALLIED INDUSTRIES EXPOSITION will be opened in the new Wrigley Bldg., Chicago June 1. Chicago is the recognized center of this industry.

THE ABBE ENGINEERING CO., New York City, has added to its staff H. H. Wilson, an engineer formerly connected with the Westinghouse Electric & Mfg. Co. Mr. Wilson has also been chief engineer of the Colorado Electric Power Co. and superintendent of the Ontario Power Co. and its subsidiaries and has had considerable experience with machinery in chemical and electrochemical plants.

LESLIE H. ALLEN, who has recently been with Fred T. Ley & Co., contractors, of Springfield, Mass., first as an industrial housing engineer and then as sales manager for the New England territory, has joined the staff of the Portland Cement Association, Chicago, as assistant manager of the Cement Products Bureau.

GEORGE C. DEAN, CLAIR W. FAIRBANK, IRVING M. OBRIEGHT and MORRIS HIRSCH announce the removal of their office to the Park Row Bldg., New York City, where they will continue the practice of patent, trade mark and corporation law under the name of Dean, Fairbank, Obrieght and Hirsch.

THE ALBERHILL COAL & CLAY CO., 608 Pacific Electric Bldg., Los Angeles, Cal., has established a research laboratory in Los Angeles, which is open to all manufacturers of clay products for experimental work. The company is carrying on a campaign for bringing to Los Angeles new industries which will be users of clay products.

THE WHITE MOUNTAIN CHEMICAL CO. has recently been organized for the manufacture of chemical compounds. H. J. St. Yves is president, I. J. Nobert vice-president, A. E. Provost treasurer and E. H. Archambault assistant-treasurer. The company is located at 1061 Elm St., Manchester, N. H.

WILSON H. LOW and JOHN H. SHOW have purchased the plant built by the California Chemical Products Co., about nine miles south of Lone Pine, Cal., near the north end of Owens Lake. They intend to recover alkali salts from the waters of Owens Lake, and will manufacture soda ash and caustic soda. They may also recover sodium sulphate and some potassium salts. Messrs. Low and Show were formerly chief chemist and assistant chemist respectively for the Cudahy Packing Co., Omaha, Neb. Later Mr. Show was identified with the first and most successful of the companies producing potash from the lakes in western Nebraska.

THE ROSS HEATER & MFG. CO., INC., announces the opening of a branch office at 2 Rector St., New York City, which will be in charge of C. M. Hardin, who was formerly located in the home office in Buffalo, N. Y.

THE ENGINEERING BUSINESS EXCHANGE announces that John J. Swan has become associated with it. Mr. Swan was formerly with the Prest-O-Lite Co.

THE POWER SPECIALTY CO., manufacturer of Foster superheaters, economizers and oil stills, has opened the following additional offices: 512 Reliance Bldg., Kansas City, Mo., and 627 Linz Bldg., Dallas, Tex. The Kansas City office is in charge of William F. Meyer, who has been with the company for many years, and the Dallas office is in charge of M. W. Brown.

The Chicago office of the UEHLING INSTRUMENT CO., of New York, was moved May 1 to the Great Northern Bldg., 20 West Jackson Blvd. Walter C. Lane has been appointed manager of this office.

THE INTERNATIONAL NICKEL CO. announces the removal of its offices to 67 Wall St., New York City.

THE NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES has moved its office from 480 Lexington Ave. to 342 Madison Ave., Canadian Pacific Bldg., New York City.

THE HAUCK MFG. CO., Brooklyn, N. Y., has elected as its president Henry T. Gerdes, mechanical engineer and manufacturer, of New York; first vice-president, M. C. Hauck; second vice-president, A. B. Hauck; third vice-president, H. H. Kress; treasurer, A. H. Stein, and secretary, J. Lutz. Mr. Gerdes, who succeeds the late Arthur E. Hauck, is a graduate of Stevens Institute of Technology and was for many years manager of the Treadwell Engineering Co. of Easton, Pa.

MANNING, MAXWELL & MOORE, INC., New York City, announces the election of J. M. David as president to succeed the late A. J. Babcock. Mr. Davis was formerly vice-president of the Baltimore & Ohio R.R. and general manager of its New York and Staten Island rail lines and terminals.

F. J. RYAN & CO., Philadelphia, Pa., announce they have just completed the installation of a large electric processing and solvent recovery equipment for the Termoid Rubber Co., Trenton, N. J., and an electrically heated belting table for the Victor Balata & Textile Belting Co., Easton, Pa. The Mircs fuel-burning department, which has recently been added to the organization, announces the following installations: 1 large annealing oven, Mare Island Navy Yard, Cal.; 1 double chamber forging furnace, Naval Airship Construction, Lakehurst, N. J.; 5 pit annealing furnaces, 1 non-ferrous annealing furnace and 2 drying ovens, Bridgeport Screw Co., Bridgeport, Conn.

THE STEEL FABRICATING CO. announces the completion of its new works and general offices at Michigan City, Ind., and the removal to that city from Harvey, Ill., of its executive headquarters.

New Publications

BOOKS

PRINCIPLES OF PHYSICAL CHEMISTRY. Second edition. By *Edward W. Washburn*, professor of ceramic chemistry in the University of Illinois. Pp. 516; 83 illustrations. New York: McGraw-Hill Book Co., Inc., 1921. Price, $4.

In this new edition the general plan and arrangement of subject matter adopted in the first edition have been retained and the revision has consisted chiefly in the incorporation of new material representing the scientific advances which have been made during the past six years. Apart from minor changes, the topics included in the new material may be summarized thus:

In Chap. I on the structure of matter, the determination of the mass of an atom by the positive-ray spectograph of Aston; in Chap. III on the liquid state of aggregation, deductions from Poiseuille's law on the flow of fluids through capillary tubes and on plastic flow; in Chap. V on the crystalline state of aggregation, the Hull method for X-ray crystal analyses, illustrations of the crystal lattice of some simple substances, atomic diameters in the crystal lattice; in Chap. VI on crystal-gas systems, the kinetics of sublimation and condensation at crystal surfaces, rates of condensation and sublimation; in Chap. X on some principles relating to energy, a brief discussion of entropy, the quantum theory, the third law of thermodynamics and the Nernst heat theorem; in Chap. XIII on the thermodynamic environment of ideal solutions, the nature of the forces which determine thermodynamic environment; in Chap. XVII on conductance and the degree of dissociation, an amplified treatment of the viscosity correction; in Chap. XX on the heat capacity and internal energy of material systems, the Jefferies-Norton apparatus for the liquefaction of gases; in Chap. XXI on chemical kinetics, contact catalysis; in Chap. XXIV on the phase rule, the system SiO_2, general temperature-composition diagram for two-component systems, three-component systems, solid models; in Chap. XXV on disperse systems, adsorption equilibrium; in Chap. XXVII on atomic structure and the periodic system, a detailed, illustrated exposition of the Lewis-Langmuir theory. To the miscellaneous problems in the appendix has been added a set of problems illustrating the application of physicochemical principles to the Lane and Lane-Bergius processes for the manufacture of hydrogen.

CONDENSED DESCRIPTION OF THE MANUFACTURE OF BEET SUGAR. By *Franz Murke*, Ph.D. Pp. 175. New York: John Wiley & Sons, Inc., 1921. Price, $2.50.

In this book the steps in the process of preparing sugar from beets are treated in a concise, yet clear, form. Chemical, engineering and economic problems are all taken into consideration and the presentation is thoroughly practical. Thus in the chapter on evaporation the method of calculating the heating surfaces for any type of vapor distribution is given in detail. The chapters in order are: Harvesting; storing and receiving beets; fluming, washing and weighing beets; cutting beets; diffusion process; pulp; diffusion juice; first carbonation; filter presses; after-purification; evaporation; thick juice saturation and filtration; first fillmass and remelt sugars; further operations with the first fillmass; after-product operations; lime kiln; Steffens separation; osmose process; boiler house; miscellation; tables for calculations.

RUBBER, RESINS, PAINTS AND VARNISHES. By *E. S. Morrell*, M.A., Ph.D., F.I.C., and *A. de Waele*, A.I.C. Pp. 236; 33 Figs. New York: D. Van Nostrand Co., 1920. Price, $4.

This volume of Dr. Rideal's series on industrial chemistry covers a number of important and interesting industries. The book is divided into five parts: part I is devoted to the rubber industry, rubber substitutes and synthetic rubber; part II to the drying oils, including the action of driers; part III to resins and pitches; part IV is divided into two sections, (1) pigments and paints, (2) linoleum, floorcloth and cork carpet; part V, on varnishes, has sections on the oil, insulating, spirit, and cellulose ester types of varnishes and on the methods of analysis. Bibliographies and an index complete the volume.

ORGANIC MEDICAL COMPOUNDS. By *M. Barrowcliff*, M.B.E., F.I.C., and *Francis H. Carr*, C.B.E., F.I.C. Pp. 331; 24 Figs. New York: D. Van Nostrand, 1920. Price, $4.

In preparing this volume for Dr. Rideal's series on industrial chemistry, the authors have endeavored to treat the preparation of organic medicinal compounds on an industrial scale. Thus the method given for the manufacture of ether is that in use at H. M. factories Pembrey and Gretna. The compounds are grouped as follows: Narcotics and general anæsthetics; naturally occurring alkaloids and their derivatives; natural and synthetic local anæsthetics; antipyretics and analgesics; organic antiseptics and disinfectants; purgatives; vaso-constrictors and vaso-dilators; diuretics and uric acid solvents; organo-metallic compounds; the digitalis group; skin irritants, glucosides and neutral principles.

URANIUM IN STEEL. Pp. 32; 20 Figs. Pittsburgh, Pa.: Standard Alloys Co.

This little book, attractively bound and printed, gives a brief account of the history of uranium, its chemical determination in ores and steels, and its properties as an alloying element. Physical test charts and records of isolated tests are given to show that steels containing but a small percentage of uranium have an unusually high merit number on account of a very material ductility in hardness specimens after a low draw.

PAMPHLETS AND CLIPPINGS IN A BUSINESS LIBRARY. By *Virginia Fairfax*. Pp. 62. San Francisco: *Journal of Electricity and Western Industry*.

Coming Meetings and Events

AMERICAN CHEMICAL SOCIETY will hold a meeting at Rumford Hall, Chemists' Club, New York City, on June 10.

AMERICAN CHEMICAL SOCIETY, THE SOCIETY OF CHEMICAL INDUSTRY and the American Section of the latter society will hold a joint meeting in New York, Sept. 6 to 10.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its fall meeting in Lake Placid, N. Y., Sept. 29 and 30, and Oct. 1.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its spring meeting June 20 to 24 at Detroit. Industrial excursions will be made to Ann Arbor, Saginaw, Midland and Bay City.

AMERICAN LEATHER CHEMISTS ASSOCIATION will hold its eighteenth annual meeting at the Hotel Ambassador, Atlantic City, June 9, 10 and 11.

AMERICAN MINING CONGRESS AND NATIONAL EXPOSITION OF MINES AND MINING EQUIPMENT will hold its twenty-fourth annual convention in the Coliseum, Chicago, Oct. 17 to 22.

AMERICAN SOCIETY FOR STEEL TREATING will hold its third annual convention and exhibition Sept. 19 to 24 at Indianapolis.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its 1921 annual meeting in the New Monterey Hotel, Asbury Park, N. J., during the week of June 20. Technical sessions are scheduled as follows: Tuesday, on Preservative Coatings and Textiles; Wednesday, on Cement, Concrete and Road Materials; Thursday, on Ceramics, Lime and Gypsum, on Petroleum Products and on Testing Methods; Friday, on Metals.

THE NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (SEVENTH) will be held during the week of Sept. 12 in the Eighth Coast Artillery Armory, New York City.

NATIONAL FERTILIZER ASSOCIATION will hold its twenty-eighth annual convention at the Greenbrier Hotel, White Sulphur Springs, W. Va., the week beginning June 20.

NATIONAL LIME ASSOCIATION will hold its annual convention in New York City June 15 to 17.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stetters Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

SOCIETY OF CHEMICAL INDUSTRY (BRITISH) at the invitation of the Montreal section will hold its annual meeting in Montreal and other Canadian cities during the week of Aug. 29, 1921. Details will be printed in this magazine from time to time.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month, except June, July, August and September.